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*Conseil Permanent International pour  
l'Exploration de la Mer*

CHARLOTTENLUND SLOT — DANEMARK

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ANNALES BIOLOGIQUES

VOLUME NO. XIII

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## **Scheme for the Arrangement of the Material**

### **I. Review of Investigations and Essential Results**

Each Committee Chairman should here give a summary of the contributions received, i. e., a statement of the nature of the material as well as a short review of the position in the area—including the main results obtained—during the last calendar year (unless otherwise stated). This review should only in exceptional cases exceed 2 pages (about 10,000 units of type). Papers should reach the General Secretary not later than 1. May.

### **II. Tables and Conclusions**

#### **A. Environment**

1. Strength and direction of currents: Especially data collected during spawning seasons.
- 2a. Temperature and salinity conditions: Tables and/or diagrams including anomalies.
- 2b. Seasonal temperature variations at selected stations: Data including anomalies.
3. Phosphate concentration, oxygen, etc.: Tables and diagrams to include anomalies.
4. Plankton conditions: Tables and/or diagrams, especially anomalies in distribution of indicator forms, phytoplankton patches, amount of plankton and fat content.
5. Abundance of benthonic food: Data.
6. The main meteorological features of the year: Data especially as to sunlight, rainfall, and direction and force of the wind.

#### **B. The Fish**

For each species in the following order: Gadoids (cod, haddock, saithe, others), flatfishes (plaice, dab, flounder, sole, witch, lemon sole, halibut, others), herring, sprat, mackerel, other pelagic fishes, eel, redfish, others.

1. Abundance and distribution of eggs and larvae.
2. Abundance of year-classes: Data derived from experimental hauls.
3. Size- and age-composition of commercial catches or landings.
4. Average length of age-groups: Data from experimental hauls and commercial catches, with standard deviations.
5. Rate of growth: Data from marking experiments and quantitative experimental hauls.
6. Rate of mortality: Data from marking experiments and quantitative experimental hauls.
7. Intensity of fishing: Data as to the fisheries considered in 3, 4, and 8.
8. Quantities landed:—
  - (a) Total catch (weight) of special fisheries.
  - (b) Percentage of large, medium, and small.
  - (c) Total number of the various species.
  - (d) Size- and age-composition of commercial catches or landings.

#### **C. Shellfish**

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## PREFACE

It appears from the number of pages, tables, and figures in this volume of the *Annales Biologiques* that the size of this periodical is still increasing—in spite of denser setting and smaller headings. It brings more and more valuable information relating to the year in question but, at the same time, it becomes more and more time-demanding for the busy scientist to obtain a quick survey. Clear sectional introductions such as those given by the chairmen of the Distant Northern Seas, the Near Northern Seas, the Baltic-Belt Seas, and the Herring Committees would greatly aid the reader by saving his time, and help him to get through to the features which are most important to him. It is also requested that all authors do their best to keep their contributions as short and clear as possible, bearing in mind the "Scheme for Arrangement of Material" printed every year on the second cover page of the "Annales".

Concerning the hydrographical conditions in 1956 much detailed information is given. In the northern waters the monthly anomalies of the surface temperature are still positive and, in the central part of the northern North Atlantic, even higher than last year but slightly lower in the east, south, and west. In the ocean west of the Faroes and in the Davis Strait a thicker layer of warm Atlantic water was found than in any year since 1948. There was a moderate inflow of Atlantic water into the northern North Sea. The temperature on the Bløden Ground was very low in spring and early summer and, in autumn, the mixing of water masses occurred a month earlier than usual. There was also a heavy outflow from the Baltic and a strong stratification north of the Dogger Bank. In the Baltic-Belt area the water temperature was below the normal, especially in the first half of the year.

As regards the **cod** the predominating year-classes in West Greenland waters were: —

On the offshore banks, 1947, 1950, and 1945.

Inshore waters, 1950, 1947, and 1945.

It is to be feared that the 1947 brood from these waters will be lost for East Greenland and Iceland, as is now the case with the 1945 brood. At South Greenland the 1950 broods was predominant, and at East Greenland the broods from 1945, 1947, and 1949 made out the main bulk of the catches. At West Greenland the 1953 brood seems to be promising. At Iceland the broods from 1947 (about 58%) and 1949 were the strongest; the 1949 brood in East Greenland waters is thought to be of Icelandic origin. In the distant northern European waters the following year-classes were predominant: —

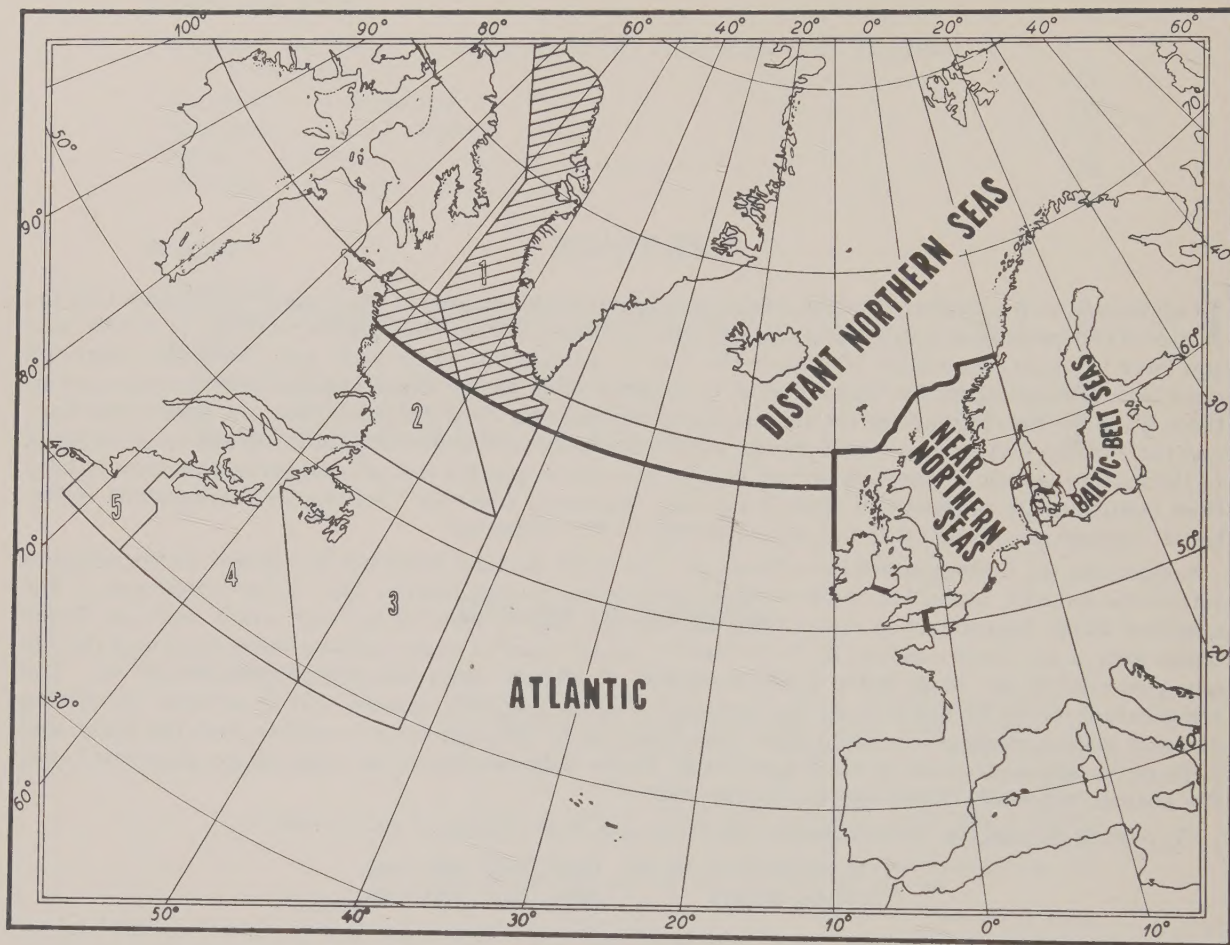
| Coast of Norway | Bear Island | Spitsbergen | Finnmark | Skolpen Bank |
|-----------------|-------------|-------------|----------|--------------|
| 1948            | 1950        | 1950        | 1950     | 1950         |
| 1950            | 1951        | 1951        | 1949     | 1949         |
| 1949            |             | 1948        | 1948     | 1948         |

The 1953 brood gave fine yields to the Polish catches in the Baltic. In the southern Kattegat the 1956 brood was good, but below the average, or poor, in the northern Kattegat, Oslo Fjord, and at the Norwegian Skagerak coast owing to the cold winter of 1955—56.

As to the **haddock** four broods were predominant at Iceland (1949, 1950, 1951, and 1952), and in Faroe waters the 1954 and 1953 year-classes predominated. In northern waters the richest broods were those of 1948 and 1950 at the Norwegian coast, 1950 (and 1953) in the Barents Sea, and 1950 and 1951 at Bear Island, Finnmark, and in the Skolpen area. The North Sea stocks were mostly composed of young fish (1953, 1954, and 1955), but the 1956 brood was found to be rather poor.

**Saithe.** Better yields at Iceland than in 1955, and the first upward trend there since 1951. The catches consisted mostly of young fish (1948—51 year-classes). At Faroes the broods from 1945, 1946, and 1949





Map showing the areas covered by the new Area Committees of the I.C.E.S., and the area of Panel 1 of I.C.N.A.F. (hatched) which is also within the boundary of the Distant Northern Seas Committee.

were most abundant. At Svinøy the spawning stock was composed of relatively young fish (1948—51), and on the Lofoten banks the broods from 1949, 1950, 1951, and 1952 were predominant.

Information is scarce as to the **whiting**, but it appears that in 1955 the yield (cwt.) per effort (100 hrs.) by British steam trawlers from the North Sea were a little higher (35 cwt.) than in 1954 (31) and in January to March 1956 average yields were 56 cwt. as compared with 39 in 1955 and 36 in 1954.

Amongst the many other fish dealt with in this volume the **herring** should be mentioned. The yields were still poor at East Anglia and north Iceland, but in Norway they were better than in any other year. Important tagging experiments have been made by Soviet scientists in the open Norwegian Sea (ca. 22,000 fish tagged in three years), and by Sweden in the Baltic.

Finally, this volume contains detailed surveys of the catches and the size distributions of the **redfish** and, for the first time, a section on **salmon** and **trout**.

Last but not least I should like to offer my best thanks to chairmen and contributors, and a special thank should be conveyed to Mrs. H. HARDER of the Central Office for her unremitting work in the preparation of this volume.

ÁRNI FRÍÐRIKSSON

# Distant Northern Seas

## INTRODUCTION

Contributions to this report have been received from: —

|               |                 |
|---------------|-----------------|
| Denmark:      | Iceland:        |
| P. M. HANSEN  | J. MAGNÚSSON    |
| F. HERMANN    | U. STEFÁNSSON   |
| J. SMED       |                 |
| England:      | Scotland:       |
| J. CORLETT    | R. B. BURNS     |
| H. W. HILL    | J. H. FRASER    |
|               | B. B. RAE       |
|               | E. WILSON       |
| Germany:      | USSR:           |
| C.-H. BRANDES | V. A. LEDNEV    |
| G. DIETRICH   | E. A. PAVSHTIKS |
| A. KOTHAUS    |                 |
| W. KRAUSS     |                 |

### Environment

The **hydrographical** contributions cover nearly the whole Distant Northern Seas area and present a fairly clear picture of the hydrographical situation. The monthly anomalies of the surface temperature in the northern North Atlantic are still on the whole positive, with a tendency, however, towards higher temperatures in the central part of the region and with slightly lower temperatures in the east, south, and west. In most reports we find indication of the year as a mild one in the sea also, as the preceding year was, e. g., north and north-east of Iceland, in the open ocean west of the Faroes with a layer of warm Atlantic water thicker than at any time since 1948, and in the Davis Strait. The hydrographical conditions in the Barents Sea are described in some length by two authors, and the conditions around Iceland are also comprehensively reviewed. The routine observations in other regions are given as in previous years. Special attention is given to the study of the Polar bottom water, and wave-like fluctuations in a section across the Norwegian Current are described.

The **plankton** contributions deal with the western Barents Sea, the Norwegian Sea, and the area along the Continental Shelf to North Iceland. The dry weight of plankton in the western Barents Sea has been compared for a series of years, viz., from 1949 to 1956; it is shown that the year 1954 is remarkable by its high standing crop, particularly in summer and autumn, predominating over the three preceding and the two following years, and that it was on about the same level as 1949 and 1950. The

zooplankton in the Norwegian Sea has been studied by the Knipovich Polar Institute during 1947 to 1956, and the conditions in 1956, especially the occurrence of *Calanus*, are briefly considered in comparison with previous observations going from east to west through Atlantic to Polar waters.

The phyto- and zooplankton occurring in the current along the Continental Shelf from Scotland towards northern waters showed that the Atlantic species were carried into the Norwegian Sea and reached far north, viz., to the south-east coast of Iceland, while the Lusitanian species did not reach as far as the Faroe-Flugga line and not below 250 metres.

### The Fish

The **redfish** has been the main subject for this year's report and three papers, covering several areas, deal with the size composition of the catches and the sex ratio; the fluctuations during the seasons are also dealt with.

The areas from which size compositions are obtained, especially from commercial catches, are from west to east:— the banks in the eastern part of the Davis Strait; south-west Greenland fjords; Denmark Strait (off Angmagssalik and the Dohrn Bank); all around Iceland; Iceland-Faroe Ridge (e. g., Rosengarten); Norwegian coast (Lofoten area); Bear Island; western Barents Sea; and Spitsbergen. In several cases the "*mentella*" and the "*marinus*" types are separated, but it is pointed out that it is difficult always to distinguish the two types. The reviews given of the sizes of the fish caught in different areas and at different seasons are very valuable, and will become more so when the taxonomy and migrations of this species is better understood than at present.

The size composition of the two commercially important species of wolffish (catfish) is given from West Greenland, the larger *Anarhichas minor* and the smaller *A. lupus*, and it is reported that about 650 specimens have been marked and liberated with the aim of studying the migration of the species in these remote waters.

As previously, several records are given of **rare or exotic** fishes obtained in the Distant Northern Seas area, chiefly caught by the German research vessel "Anton Dohrn" and by commercial trawlers and liners.

Å. VEDEL TÅNING



## ENVIRONMENT

### Hydrography

#### Monthly Anomalies of the Surface Temperature in Areas of the Northern North Atlantic in 1956

(Figures 1-3; Tables 1-2)

On the basis of data collected in 1956 by the Danish Meteorological Institute from Danish and Icelandic ships in the northern North Atlantic, anomalies of surface temperature have been evaluated for each month and each 1°-square; RYDER's grand monthly means for the period 1876—1915 were used as standards. These anomalies were then averaged for the areas indicated in Figure 1.

The results are given in Table 1, where the monthly anomalies are recorded together with the numbers of the observations on which they are based. In the last column of the table the monthly anomalies for each area have been averaged for the year.

Table 1 shows that positive anomalies still predominate. In fact all the yearly anomalies given in the last column of Table 1 are positive. The distribution of the yearly anomalies over the whole region is shown in Figure 2.

The average of the yearly anomalies given in the last column of Table 1 is 0.5°C. Although this is the same as in 1955, there is some variation from 1955 to 1956 in most of the areas, as may be

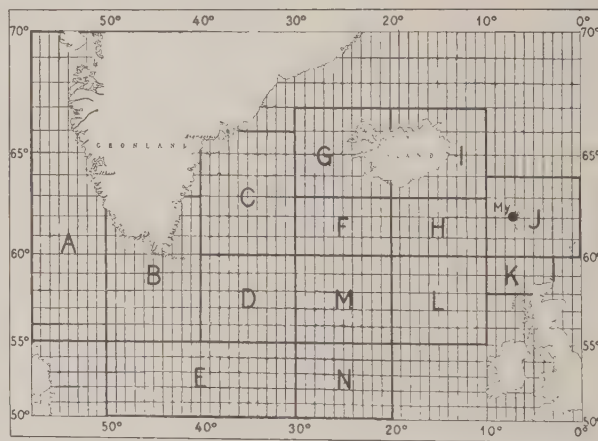


Figure 1. Location of areas A to N and station My.

seen in Figure 3, which shows the geographical distribution of the temperature variation from 1955 to 1956. There is a tendency towards higher temperatures in the central part of the region and towards lower temperatures in the east, south, and west.

Table 2 gives the grand monthly means of the surface temperature at Myggenæs, Faroes (station My in Figure 1), for the period 1914—1950,

Table 1. Monthly anomalies ( $\Delta$  °C.) and numbers (n) of observations of the surface temperature in the areas A-N during 1956 (see Figure 1)

|      | Jan.     |    | Feb.     |    | March    |    | April    |    | May      |     | June     |     | July     |     | Aug.     |     | Sept.    |     | Oct.     |     | Nov.     |     | Dec.     |    | Aver.          |
|------|----------|----|----------|----|----------|----|----------|----|----------|-----|----------|-----|----------|-----|----------|-----|----------|-----|----------|-----|----------|-----|----------|----|----------------|
|      | $\Delta$ | n  | $\Delta$ | n  | $\Delta$ | n  | $\Delta$ | n  | $\Delta$ | n   | $\Delta$ | n   | $\Delta$ | n   | $\Delta$ | n   | $\Delta$ | n   | $\Delta$ | n   | $\Delta$ | n   | $\Delta$ | n  | of             |
| A .. | —        | —  | —        | —  | -1.8     | 3  | 0.5      | 14 | 0.4      | 90  | 0.0      | 141 | 0.7      | 149 | 1.0      | 46  | 0.6      | 140 | 0.6      | 106 | -0.2     | 6   | —        | —  | $\Delta$ -val. |
| B .. | —        | —  | —        | —  | -1.3     | 16 | 1.9      | 30 | 0.7      | 105 | -0.2     | 102 | 0.1      | 107 | 0.0      | 80  | 0.3      | 89  | 0.3      | 81  | -0.5     | 82  | -0.3     | 11 | 0.2            |
| C .. | —        | —  | —        | —  | 0.8      | 12 | 0.7      | 17 | 0.3      | 63  | 0.3      | 54  | 0.8      | 63  | 0.6      | 59  | 0.4      | 52  | 0.5      | 42  | 0.8      | 10  | —        | —  | 0.1            |
| D .. | 2.9      | 12 | 0.2      | 8  | 0.6      | 33 | 1.2      | 29 | 0.1      | 34  | 0.0      | 35  | 0.0      | 27  | 0.3      | 43  | 0.0      | 31  | 0.6      | 50  | 0.2      | 50  | 0.5      | 13 | 0.6            |
| E .. | 1.1      | 56 | 1.3      | 20 | 0.3      | 66 | 0.1      | 21 | -0.4     | 51  | -0.2     | 64  | 0.0      | 45  | 0.8      | 50  | 0.5      | 61  | 0.2      | 57  | 0.8      | 55  | -0.3     | 25 | 0.4            |
| F .. | -1.2     | 3  | —        | —  | 0.8      | 29 | 0.6      | 35 | 0.6      | 80  | 0.2      | 67  | 0.1      | 68  | 0.0      | 63  | 0.7      | 39  | 1.0      | 46  | 0.5      | 55  | 0.5      | 5  | 0.3            |
| G .. | 0.2      | 10 | 1.8      | 5  | 1.5      | 13 | 0.4      | 7  | 0.9      | 10  | 0.5      | 24  | 0.1      | 25  | 0.4      | 12  | 1.0      | 24  | 0.6      | 20  | 1.3      | 12  | 1.0      | 12 | 0.8            |
| H .. | 0.5      | 39 | 1.0      | 32 | 1.1      | 48 | 0.5      | 58 | 0.7      | 90  | 0.5      | 107 | 0.2      | 111 | -0.1     | 126 | 0.6      | 98  | 0.4      | 87  | 0.8      | 115 | 1.1      | 48 | 0.6            |
| I .. | 0.3      | 7  | 1.1      | 7  | 1.6      | 15 | 1.5      | 7  | 1.8      | 10  | 1.3      | 9   | 0.9      | 18  | 1.3      | 17  | 1.2      | 18  | 0.5      | 15  | 1.4      | 12  | 1.1      | 8  | 1.2            |
| J .. | 0.4      | 41 | 0.8      | 41 | 0.8      | 56 | 0.8      | 38 | 0.4      | 63  | 0.3      | 91  | 0.4      | 80  | -0.2     | 69  | 0.2      | 67  | 0.4      | 58  | 0.4      | 70  | 0.8      | 48 | 0.5            |
| K .. | 0.4      | 58 | 0.0      | 47 | 0.7      | 42 | 0.4      | 27 | 0.3      | 69  | 0.4      | 61  | 0.1      | 72  | -0.4     | 60  | -0.1     | 70  | 0.2      | 54  | 0.3      | 43  | 0.3      | 31 | 0.2            |
| L .. | 1.0      | 71 | 1.0      | 44 | 0.9      | 41 | 0.8      | 14 | 0.3      | 60  | 0.2      | 45  | -0.2     | 51  | -0.5     | 49  | 0.1      | 49  | 0.4      | 44  | 1.0      | 35  | 0.4      | 39 | 0.5            |
| M .. | 1.3      | 60 | 1.2      | 49 | 0.4      | 39 | 1.1      | 11 | 0.5      | 49  | 0.0      | 44  | -0.5     | 40  | -0.3     | 51  | 0.3      | 56  | 0.3      | 53  | 1.0      | 46  | -0.1     | 46 | 0.4            |
| N .. | 0.6      | 5  | —        | —  | 0.5      | 6  | 1.1      | 6  | -0.5     | 23  | -0.4     | 26  | -0.8     | 2   | 1.4      | 12  | —        | —   | —        | —   | 1.2      | 2   | 0.1      | 2  | 0.4            |

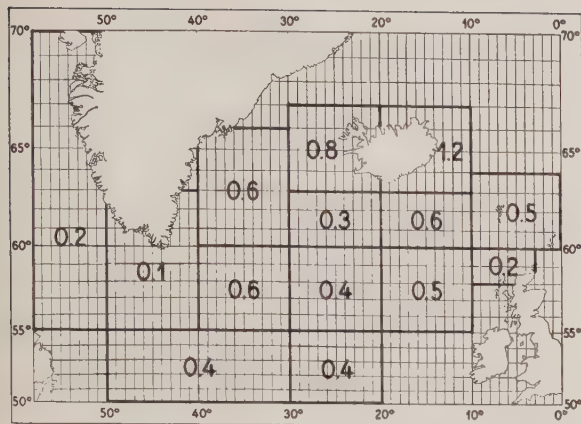


Figure 2. Yearly anomalies of surface temperature (°C.) for 1956.

Table 2.

Grand monthly means of the surface temperatures (°C.) at Myggenæs, Faroes (My in Figure 1) during the period 1914–50 and deviations for 1956 from these means

|                 | Jan. | Feb. | March | April | May | June |
|-----------------|------|------|-------|-------|-----|------|
| Means 1914–50   | 6.3  | 6.0  | 5.9   | 6.3   | 7.1 | 8.2  |
| Deviations 1956 | –0.7 | –0.2 | 0.4   | 0.1   | 0.3 | 0.2  |

|                 | July | Aug. | Sept. | Oct. | Nov. | Dec. | Year |
|-----------------|------|------|-------|------|------|------|------|
| Means 1914–50   | 9.3  | 9.8  | 9.7   | 9.1  | 7.9  | 7.0  | 7.7  |
| Deviations 1956 | 0.2  | –0.3 | 0.0   | –0.1 | 0.4  | 0.2  | 0.0  |

together with deviations of the 1956 values from these means.

I am greatly indebted to Messrs. I. SESTOFT and H. THOMSEN of the Danish Meteorological Institute for placing the data at my disposal.

JENS SMED

### Hydrographic Conditions in the Barents Sea during 1956

(Figures 4–31; Table 3)

The English and Norwegian arctic teams agreed to co-operate as far as possible in 1956 in an attempt to obtain a wider coverage of hydrographical observations in the Barents Sea including a minimum of four hydrographic sections to be worked in March–April, September–October, and November–December. These were:—

- (i) East from Bear Island along the 74°25'N. parallel as far as 30°23'E.
- (ii) West from Bear Island along the 74°25'N. parallel as far as 13°00'E.
- (iii) Fugløy to Bear Island.
- (iv) Vardø to Goose Bank.

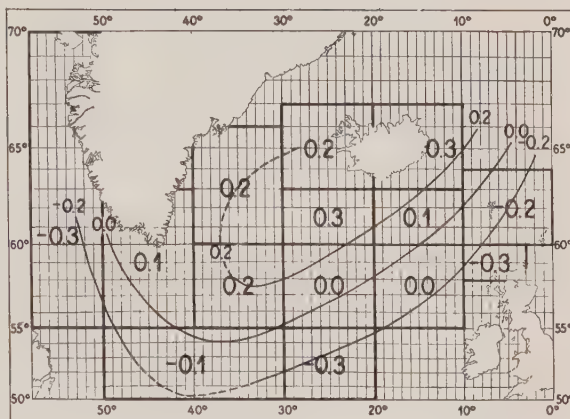


Figure 3. Variation of surface temperature (°C.) from 1955 to 1956.

The research vessel “Ernest Holt” made six cruises to the Barents Sea during which the first three sections were each worked three times; in March–April, September–October, and December; and the Vardø to Goose Bank section was worked in December. In addition Stations S (74°25'N., 16°08'E.) and W (74°25'N., 13°00'E.) were worked in January, May, and July so that the volume transport across the West Bear Island section could be computed for each cruise, and in September they were each worked four times within two days giving four independent values of the transport to provide an estimate of the reproducibility of the results. Various other sections were also made, including one off Malangen in March and September. The positions of all these sections are shown in Figure 4. On each cruise bottom temperature and bottom salinity observations were taken and a thermograph was run continuously at 4.5 m., except during May and June when it was under repair following damage by ice on the previous cruise.

### Surface temperature

The surface temperature distribution in the entrance to the White Sea at the end of January was very similar to that at the same time in 1953, described by LEE (1956), but the Murman Current was 1°C. colder, reaching only 4°C. The colder water pushing north-west from the White Sea had reached further north than in 1955 and crossed the North Deep to the Skolpen Bank. South-west of Bear Island the 4° and 5° isotherms corresponded roughly with the 100 fathom and 200 fathom isobaths respectively, and water between 3°C. and 6°C. extended from Bear Island to the Norwegian coast.



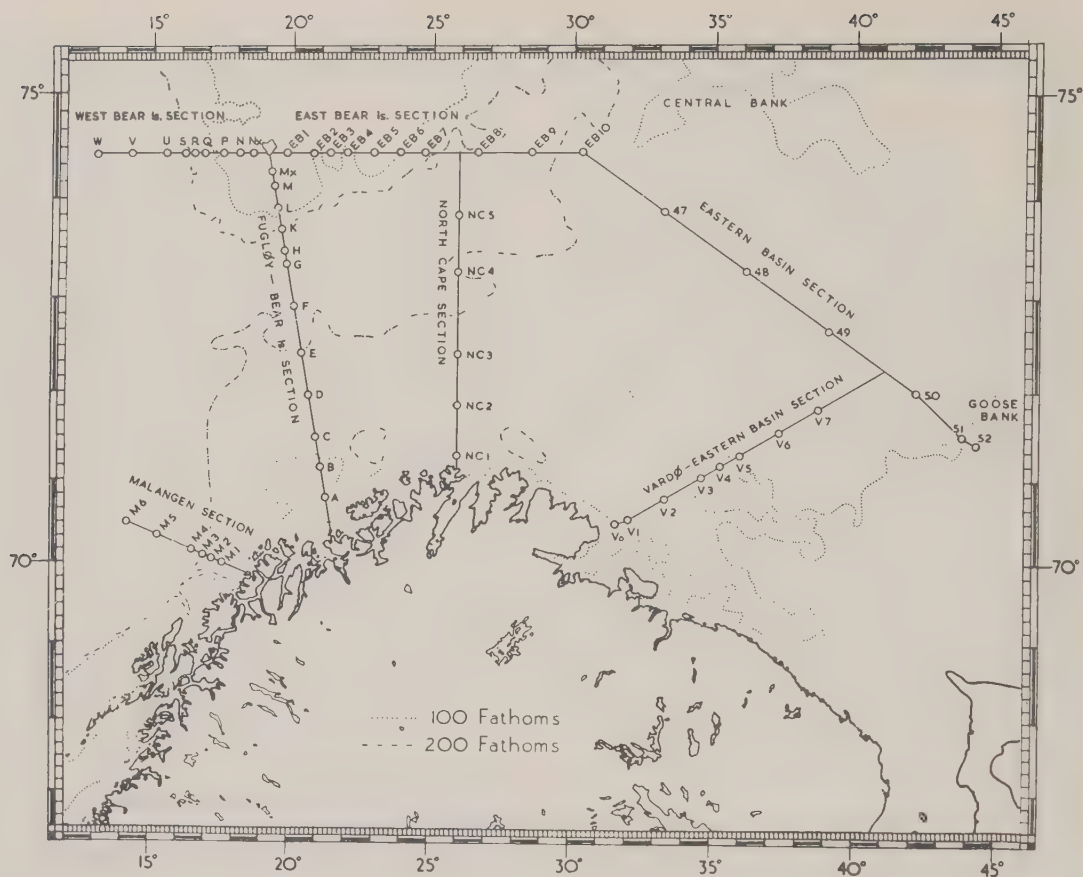


Figure 4. Positions of sections worked by the R/V "Ernest Holt" in 1956.

Conditions at the end of March and beginning of April were again very similar south of Bear Island to those observed in 1955, but there had been considerably more mixing so that the fronts between the Atlantic and arctic waters south-west and south of the island were more gradual. To the east of the island however, conditions were different, and pack ice extended as far as  $23^{\circ}53'E$ . By 2. April pack ice also reached south of Bear Island to  $74^{\circ}08'N$ ,  $18^{\circ}54'E$ . where a few days previously the sea had been clear. The  $5^{\circ}$  isotherm which ran between North Cape and the Bear Island Bank was pushed westward by approximately 20 miles in 9 days in the middle of April by gale force south-easterly winds.

Figure 5 shows the temperature distribution at 4.5 m. at the end of July and beginning of August. Temperatures around Bear Island had increased from  $-1^{\circ}C$ . in April to above  $3^{\circ}C$ . and the surface temperature on the West Bear Island section was

nearly  $9^{\circ}C$ . Even as far north as Prince Charles Forland the West Spitsbergen Current was still above  $7^{\circ}C$ ., two degrees higher than in 1955, and water above  $6^{\circ}C$ . covered the Storfjordrenna, which was three degrees higher than at the end of July 1955. With the exception of one or two isolated patches the surface water of the whole of the Bear Island Bank and most of the Spitsbergen Shelf was warmer than  $2^{\circ}C$ ., colder water being found only near Hope Island. In the Bear Island Channel surface temperatures were above  $9^{\circ}C$ . and a branch of the North Cape Current carried water above  $5^{\circ}C$ . up the Hope Island Deep as far as the Great Bank.

By September the surface temperatures had dropped considerably as shown in Figure 6. Water below  $2^{\circ}C$ . lay over the South East Gullies and the south-eastern edge of the Bear Island Bank and in the Bear Island Channel the temperature was between  $5^{\circ}$  and  $7^{\circ}C$ ., but it was still above  $9^{\circ}C$ .

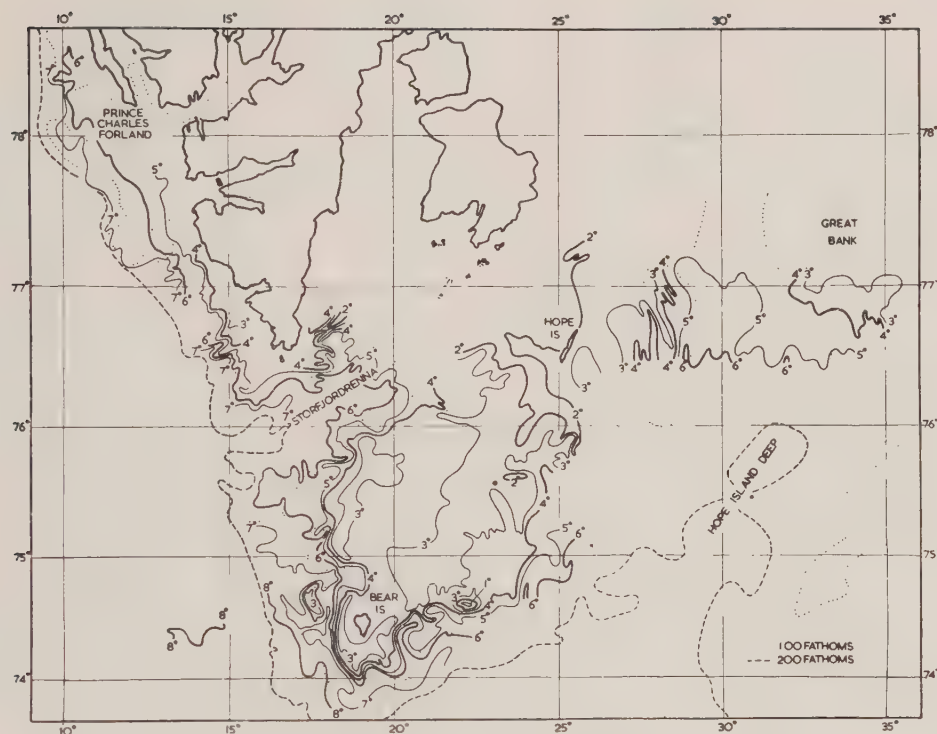


Figure 5. Surface temperatures of the Bear Island, Spitsbergen, and Hope Island areas 24. July—16. August 1956.

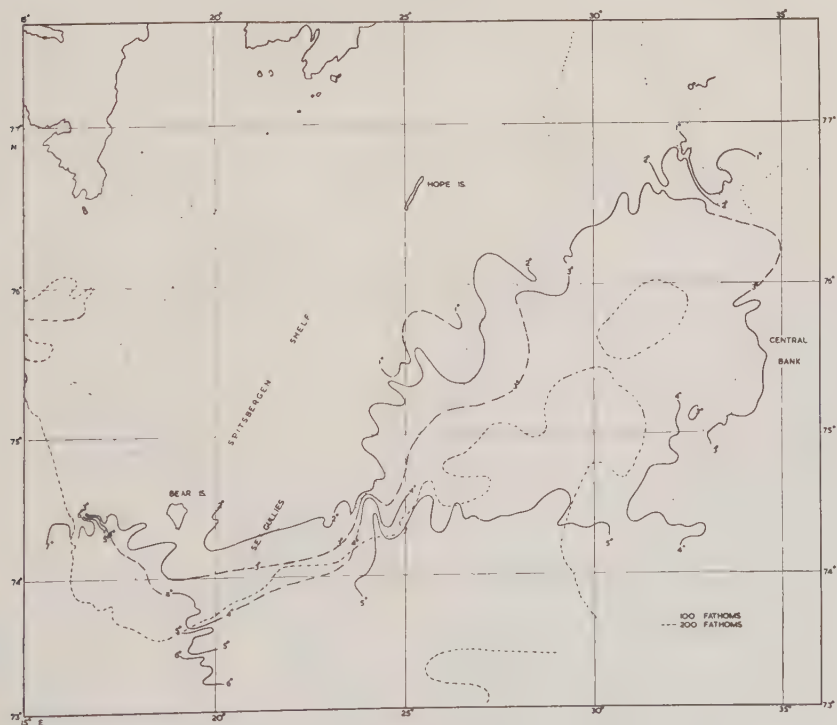


Figure 6. Surface temperatures in the Bear Island—Hope Island area 19. September—5. October 1956.





Figure 7. Surface temperature in the south-eastern Barents Sea 6.—12. December 1956.

on the Malangen section. On the southern edge of the Great Bank temperatures below 1°C. were found although the 4° isotherm still extended as far as 32°E. towards the Central Bank.

The cooling continued until the beginning of December when the water surrounding Bear Island was below 1°C., but this was still warmer than in December 1955 by about two degrees. In the West Spitsbergen Current off Bear Island and the North Cape Current, surface temperatures were found to vary between 4°C. and 6°C. and Figure 7 shows that off the Murman coast Atlantic water was split into two branches by a cold tongue pushing westwards from Goose Bank, one flowing north-east along the edge of the bank and the other south-east over the South Deep and then turning north-eastwards off Cape Kanin.

Thermograph temperatures recorded at the three control stations described by LEE (loc. cit.) show that the latter half of 1956 was atypical. At all three stations the surface temperature in September was the lowest observed over the years considered. At Station A, in Norwegian coastal water, the highest temperature so far observed for the summer, 11.6°C., was combined with the lowest as yet found during the latter months of the year. The fall in temperature here,

from summer to autumn, was thus extremely marked. At Stations F and M the December temperatures were normal indicating a reduction in the rate of cooling after the rapid fall in September. At Stations F and M the lowest November—December temperatures were recorded in 1955: at Station F the lowest March temperature was recorded in 1956. The winter of 1955—56 was therefore severe at Bear Island.

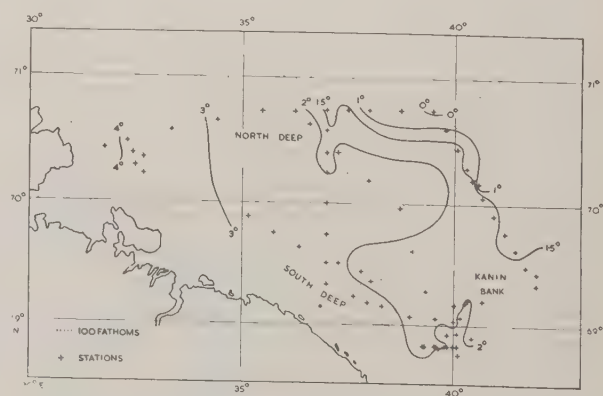


Figure 8. Bottom temperature distribution in the south-eastern Barents Sea 15.—25. January 1956.

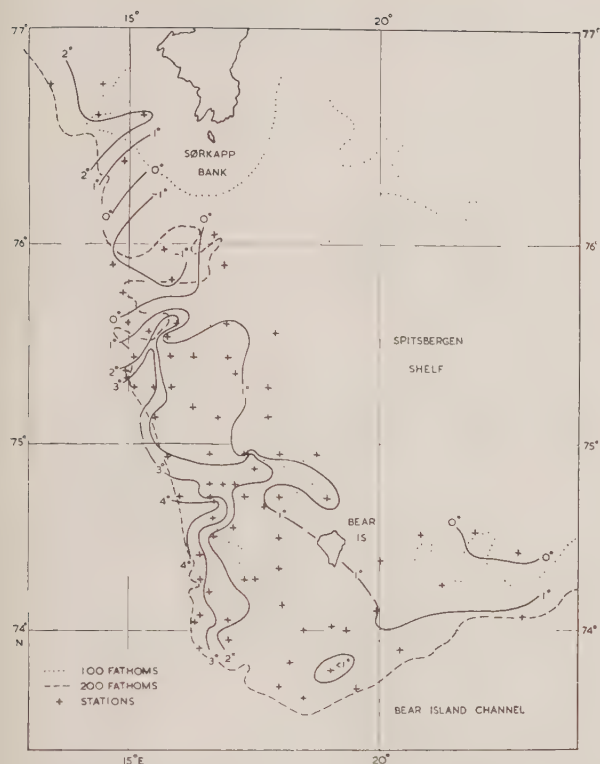


Figure 9. Bottom temperature distribution in the Bear Island-Spitsbergen area 29. May—6. June 1956.

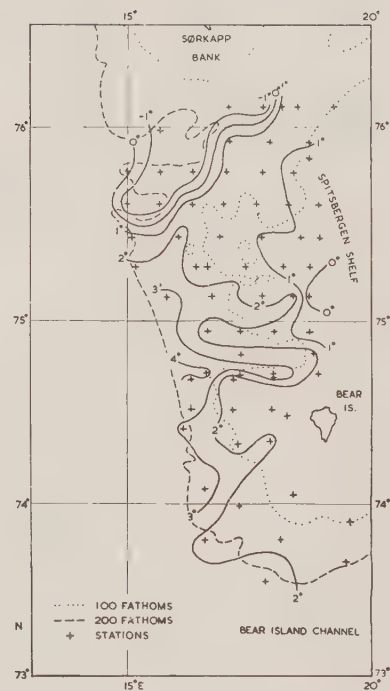


Figure 10. Bottom temperature distribution in the Bear Island-Spitsbergen area 11.—17. June 1956.

#### Bottom temperature

The bottom temperature distribution at the beginning of the year in the south-eastern Barents Sea is shown in Figure 8. Water above 2°C. did not spread as far east across the Kanin Bank as in January 1955, but had pushed well along the Murman coast by way of the South Deep.

Because of bad weather, very few bottom temperatures were taken during March and April other than at the hydrographic series stations, but it was clear that the Bear Island Bank was covered with water below 0°C., except for a narrow band west of the island in the core of the West Spitsbergen Current, where the temperature rose sharply to over 4°C. A few bottom temperature observations taken about 60 miles south-west of Bear Island appeared to be part of a small tongue of the cold Bear Island Current pushing round the south of the island and over the edge of the bank. The unusually warm bottom water found in the

Bear Island Channel in March 1955 was not present during this cruise.

The temperature distribution along the edge of the Spitsbergen Shelf in May and June is shown in Figures 9 and 10. Atlantic water pushing up the North West Gully at the beginning of June can be seen to have advanced along the gully and on to the bank by the middle of the month. A tongue of arctic water moving south-west from Sørkapp Bank had also advanced a considerable distance during the cruise, but south of it, warm water above 2°C. covered the bank as far as the 100 fathom isobath.

By the end of July the summer warming was well under way and in Figure 11 water above 3°C. is seen to have encircled Bear Island and to have covered a large area of the bank between there and Hope Island. This warm water was sandwiched between two masses of very cold water. The more northerly, covering the Storfjordrenna, is similar

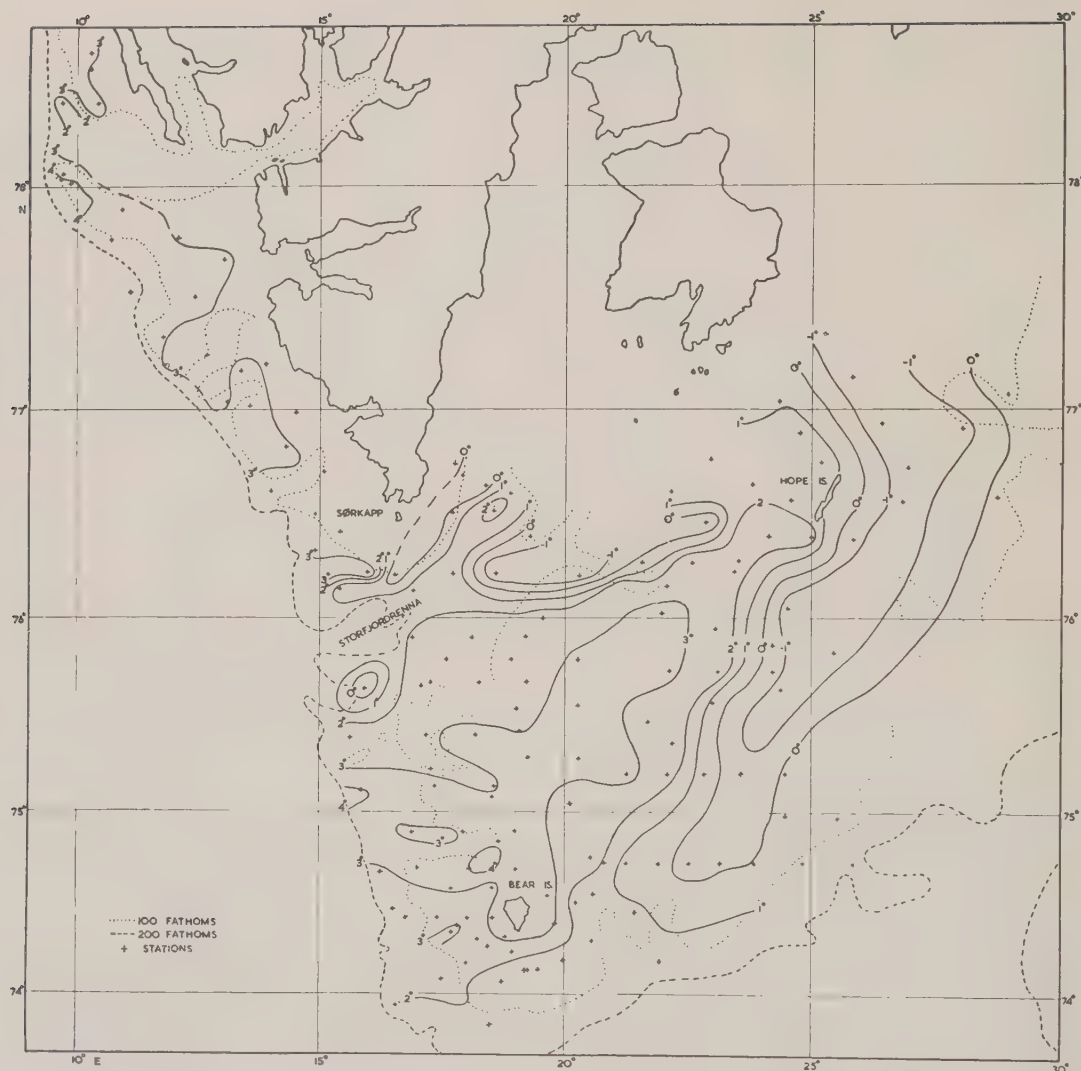


Figure 11. Bottom temperature distribution in Bear Island, Spitsbergen—Hope Island areas  
24. July—15. August 1956.

in position and origin to that described by LEE (loc. cit.) at the comparable time in 1955. The other represents the arctic water of the Bear Island Current. Conditions in the area covered by Atlantic water seem to have been on the average one degree warmer than at the end of July last year, but in contrast the Bear Island Current was colder and its effect more pronounced, while in the East Spitsbergen Current sub-zero water reached 20 miles south of Sørkapp.

In September, normally the warmest month, the temperatures are expected to be at their

maximum, but in fact were lower around Bear Island than they had been in July and August. Bottom temperatures in this mixing zone between the arctic and Atlantic water masses are partly controlled by the relative strengths of the Atlantic and Bear Island Currents. At this time the volume transport in the Atlantic Current both at Malangen, and across the West Bear Island section was small, and this probably caused the apparent anomaly by allowing a greater penetration of the arctic water. Low temperatures were also observed on the southern slopes of the Great Bank and in



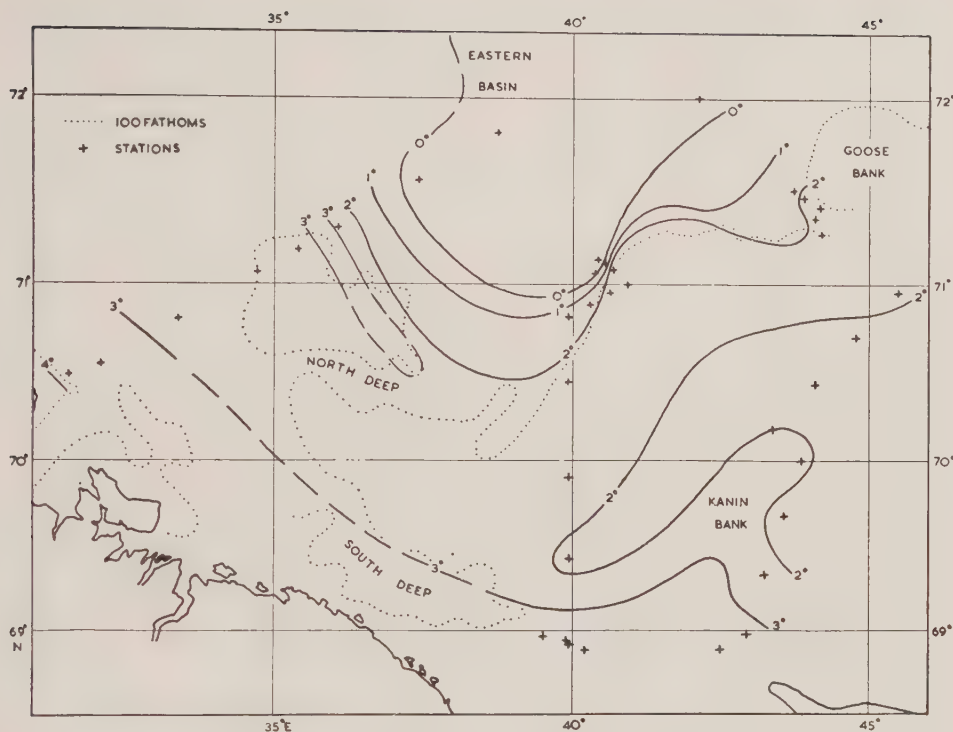


Figure 12. Bottom temperatures in the south-eastern Barents Sea  
6.—12. December 1956.

the Hope Island Deep. By the early part of December the temperatures had dropped further in the shallow water on the Bear Island Bank, but a distinct band of water above  $2^{\circ}\text{C}$ . lay along the south-eastern edge, in a mean depth of approximately 100 fathoms, and extended up into the South East Gullies. This was due to increased inflow of Atlantic water, as shown by the high volume transport for the West Bear Island section. The Murman Current is shown by Figure 12 to have been split into two by a tongue of cooler water, which is seen in Figure 17 to have been of low salinity. On the western edge of Goose Bank there was a well defined front between the Atlantic water and the cold water lying in the Eastern Basin.

#### Bottom salinity

The regular collection of bottom salinity samples, other than at series stations, first began in January 1956, so that there are no available data at similar times in previous years for comparison. However the salinity distributions on the bottom are shown in Figures 13 to 17 for all cruises in 1956 except that in March/April, when samples were

only taken at the hydrographic series stations. The conditions in the south-eastern Barents Sea can be seen in Figure 13 where salinities ranged from  $34.47$  to  $34.97\text{‰}$ , the lowest being found near the entrance to the White Sea. At the beginning of June, water of Atlantic origin lay on the bottom along the western edge of the Spitsbergen Shelf. Very high salinities were found in the Storfjordrenna ranging up to  $35.39\text{‰}$ : the associated bottom temperatures were between  $-1.40^{\circ}$  and  $-1.73^{\circ}\text{C}$ . Air temperatures were particularly severe in the winter of 1955/1956 and it appears therefore that the bottom water in that part of the Storfjordrenna had its origin not in this year's influx of Atlantic water, but in the concentrated brine remaining after the formation of ice in winter from high salinity water brought in by the West Spitsbergen Current in the summer and autumn of 1955. This water, becoming more dense, sank to the bottom and has subsequently suffered little mixing. Water with similar characteristics was found in this region at the end of July and beginning of August, the samples having salinities of  $35.16$  and  $35.22\text{‰}$  and temperatures of  $-1.46^{\circ}\text{C}$ . and  $-0.32^{\circ}\text{C}$ .

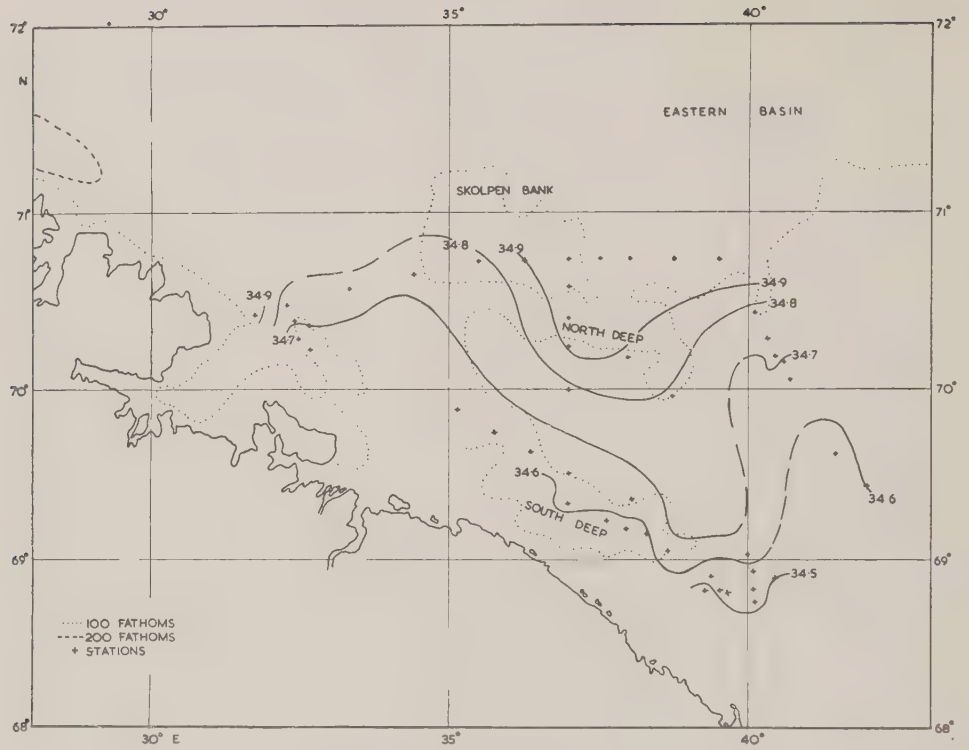


Figure 13. Bottom salinities in the south-eastern Barents Sea 15.—25. January 1956.

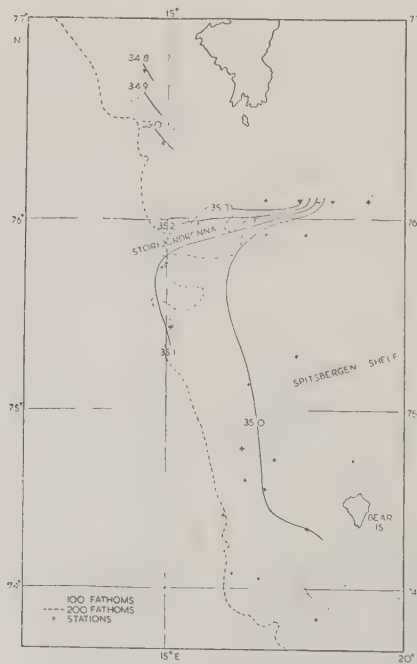


Figure 14. Bottom salinity distribution along the western edge of the Spitsbergen Shelf 29. May—17. June 1956.



Figure 15. Bottom salinity distribution on the Spitsbergen Shelf  
24. July—14. August 1956.

respectively, indicating that some mixing had taken place in the meanwhile. Figure 15 shows that at this time salinities of  $35.1^{0}_{00}$  were found on the edge of the shelf as far north as Isfjord Bank. The axis of the Bear Island Current is clearly shown to be almost directly along the line joining Bear Island to Hope Island, which is some way west of the position indicated by the bottom temperature distribution in Figure 11. On the bank in the shallower water summer warming raised the temperature of the current considerably, but did

not penetrate the deeper water to the east thus causing the axis of the current to appear in deeper water than it really was. By September the Bear Island Current had taken water with a salinity less than  $34.4^{0}_{00}$  right across the bank to surround Bear Island. The salinity distribution thus confirms the suspected greater penetration of arctic water mentioned earlier. Figure 16 also shows water of above  $35.0^{0}_{00}$  stretching up the Bear Island Channel, and salinities of  $35.07^{0}_{00}$  were observed on the slopes of the Great Bank. As its temperature



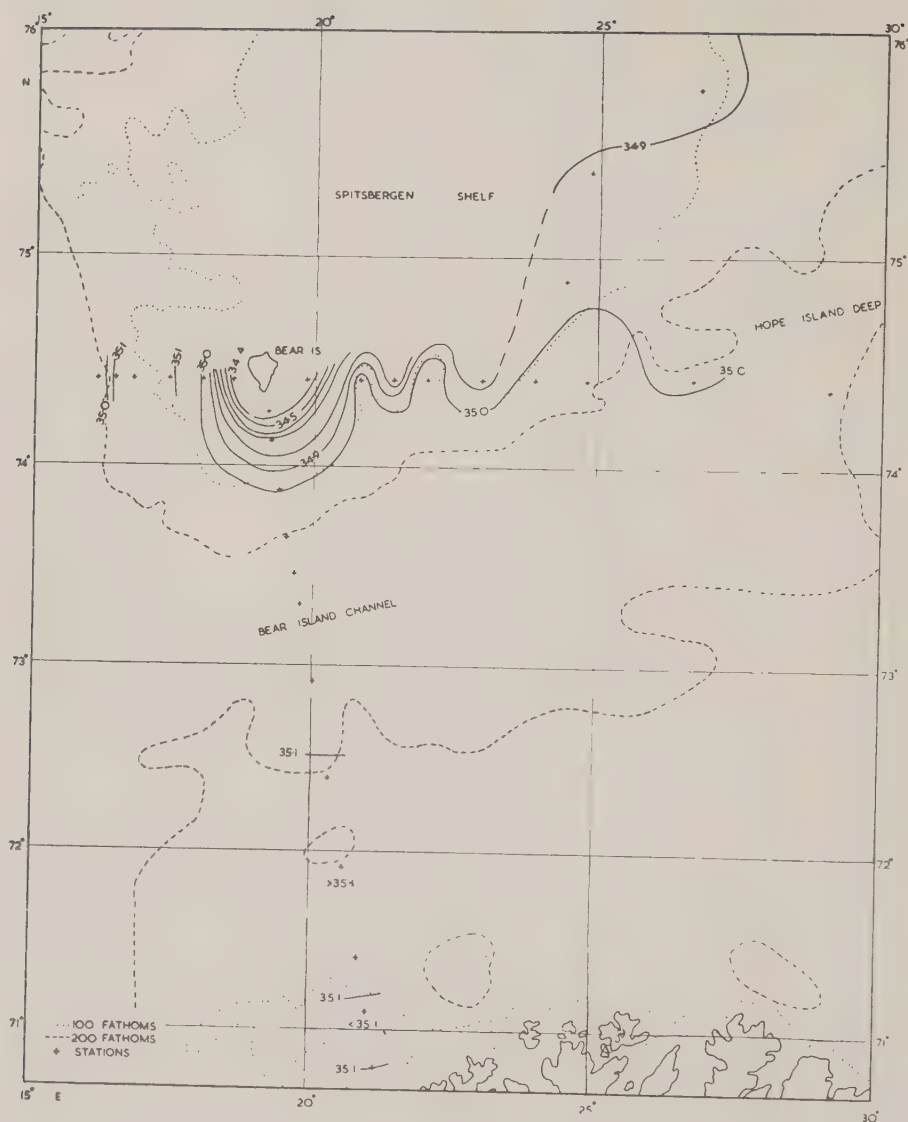


Figure 16. Bottom salinities in the Bear Island region 21.—28. September 1956.

was low and its salinity high, this bottom water was probably formed by a similar process to that found in the Storfjordrenna earlier in the year.

In the south-eastern Barents Sea the bottom salinity distribution in December, shown by Figure 17, was similar to that observed in January. A tongue of warm, low salinity water extended in a north-westerly direction from Cape Kanin to the Skolpen Bank and in December split the Atlantic water into two streams, the more northerly flowing over the cold, low salinity water on the bottom of the Eastern Basin and on to the slopes of the Kanin Bank.

#### Sections and transports

The "Ernest Holt" worked the Malangen section on 28.—29. March. Since this section has not been worked previously no comparison with earlier work is possible. However it does show the state of the Atlantic Current before it divides into the West Spitsbergen and North Cape Currents. At the surface the Atlantic water was 50 miles from the coast, as shown in Figure 18, but close to the bank the Atlantic water ran below the Norwegian coastal water and had temperatures of above 4°C. and salinities above 35.1‰ down to 700 m. No water of less than 3°C. was found on the bottom. Condi-

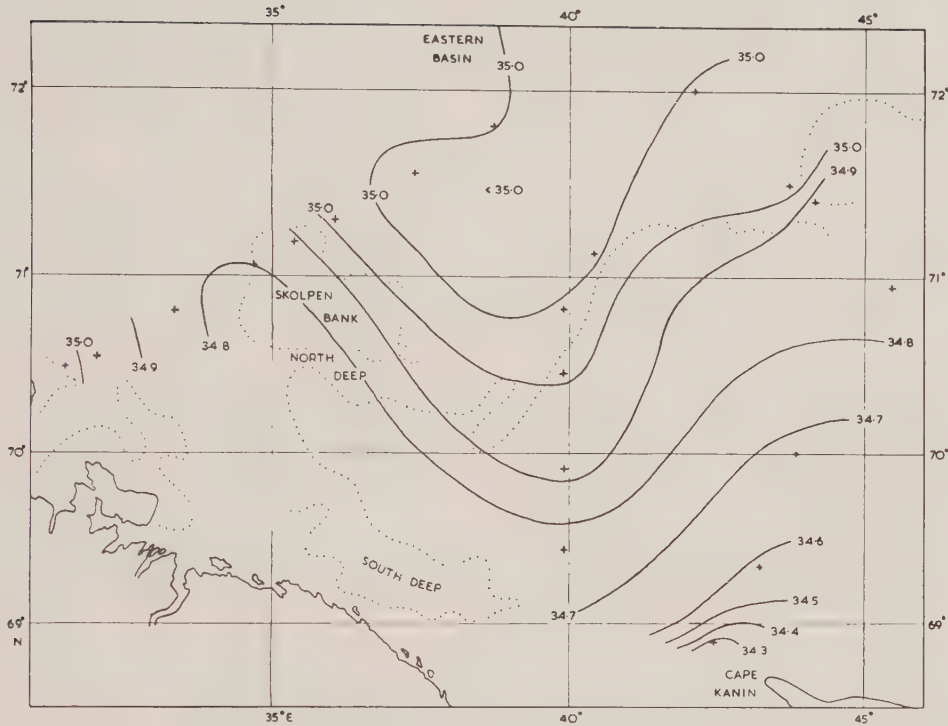


Figure 17. Bottom salinities in the south-eastern Barents Sea 6.—12. December 1956.

tions in the North Cape Current are shown by the Fugløy—Bear Island section in Figure 19. There was a considerable volume of water above  $35.1^{\circ}/_{00}$  and salinities above  $35.0^{\circ}/_{00}$  extended on the surface for 150 miles. The current was about a degree cooler than off Malangen, water above  $5^{\circ}\text{C.}$  being practically non-existent, but water above  $4^{\circ}\text{C.}$  extended north over the deep part of the Bear Island Channel down to a depth of about 250 m. Arctic water covered the Bear Island Bank, water below  $2^{\circ}\text{C.}$  lying on the edge of the shelf down to 450 m. The North Cape Section, worked on 4.—5. April, shows the state of the North Cape Current 100 miles further east. Water above  $35.1^{\circ}/_{00}$  was here reduced to a narrow band near the surface on the northern half of the section and the temperature had dropped roughly another degree, but Atlantic water still covered the bottom.

That branch of the North Cape Current which swings north-east up the Bear Island Channel is shown by the East Bear Island section in Figure 21. There was again a large volume of water above  $35.0^{\circ}/_{00}$  but only a small amount above  $35.1^{\circ}/_{00}$ , at 50 m., as on the North Cape section. Unfortunately, that part of the section on the bank, intended to show conditions in the Bear Island Current, was

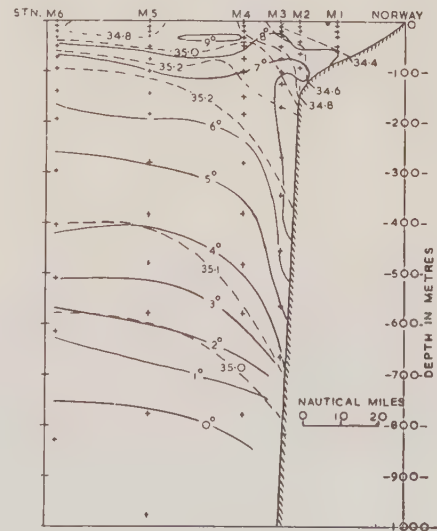


Figure 18. Temperature and salinity distributions on the Malangen section 28.—29. March 1956.

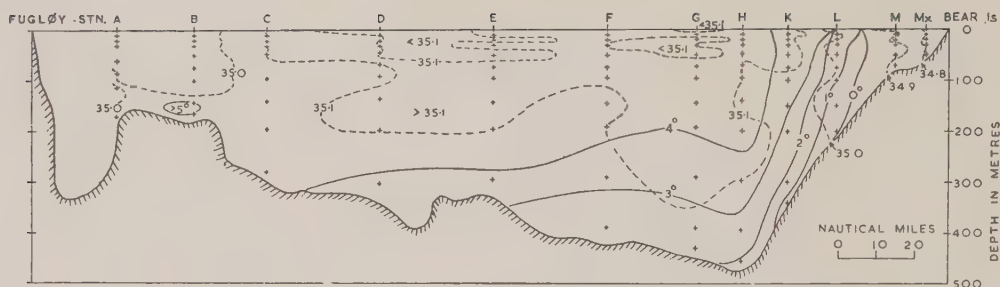


Figure 19. Temperature and salinity distributions on the Fugløy—Bear Island section 29.—31. March 1956.

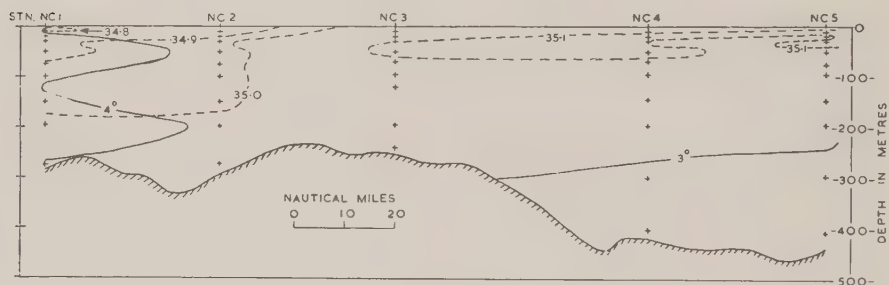


Figure 20. Temperature and salinity distributions on the North Cape section 4.—5. April 1956.

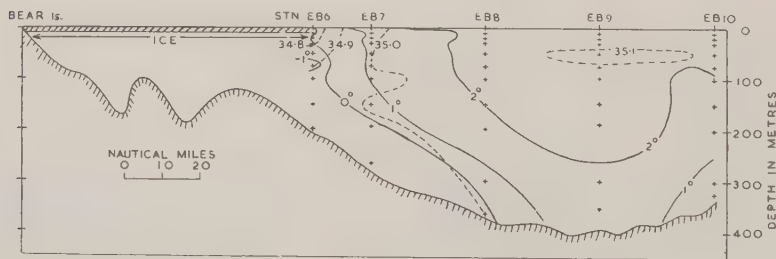


Figure 21. Temperature and salinity distributions on the East Bear Island section 3.—4. April 1956.

covered with ice and could not be worked, but near the ice edge can be seen water colder than  $-1^{\circ}\text{C}$ . and the  $0^{\circ}$  isotherm extended right down the edge of the bank into the channel. It may be noted that the highest temperature recorded in the Atlantic water here was  $2.27^{\circ}\text{C}$ . a drop of almost  $4^{\circ}\text{C}$ . from the highest on the Malangen section ( $6.14^{\circ}\text{C}$ .) in a distance of 320 miles. The branch of the North Cape Current which continues toward the Murman coast was further covered by the Norwegian research vessel "G. O. Sars" during this joint cruise.

Conditions in the West Spitsbergen Current are shown in Figure 22 by the West Bear Island Section, which may be compared with the conditions off Malangen 260 miles further south. There was a narrow wedge of water above  $4^{\circ}\text{C}$ . with a small core above  $5^{\circ}\text{C}$ . reaching down to 150 m. There was a sharper and more vertical front between the Atlantic and arctic water masses than between the Atlantic and Norwegian coastal waters and the shape of the isolines indicated a difference in the relative speeds of the currents. The West Bear Island section has been worked every year in



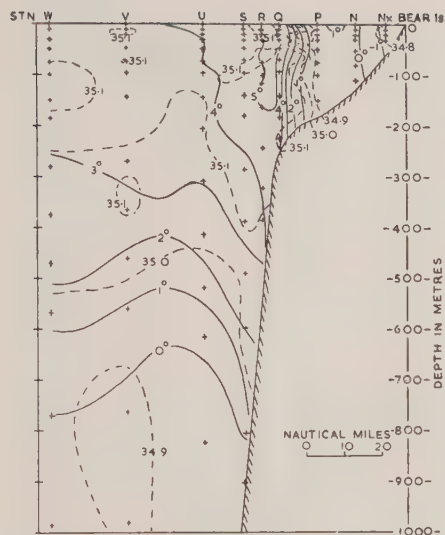


Figure 22. Temperature and salinity distributions on the West Bear Island section 31. March—2. April 1956.

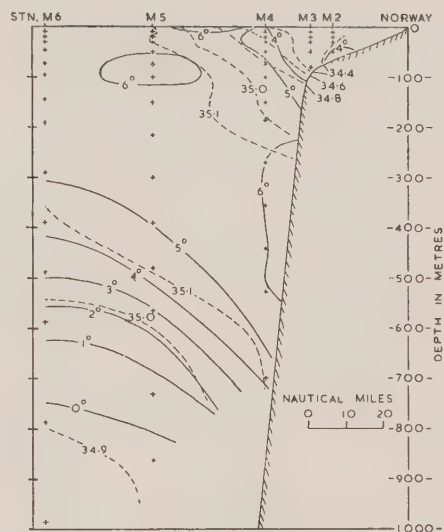


Figure 23. Temperature and salinity distributions on the Malangen section 19.—20. September 1956.

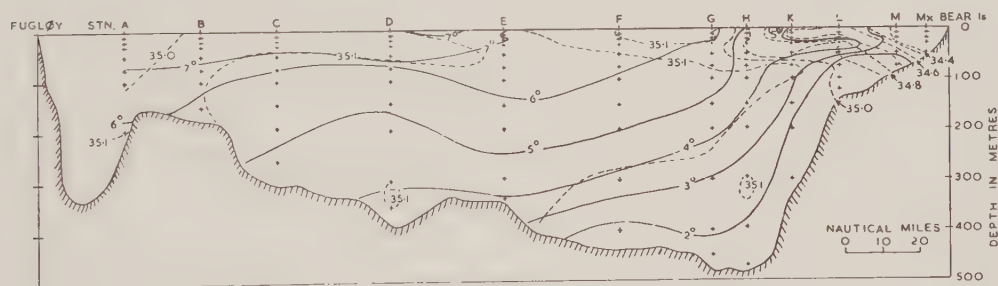


Figure 24. Temperature and salinity distributions on the Fugløy—Bear Island section 21.—22. September 1956

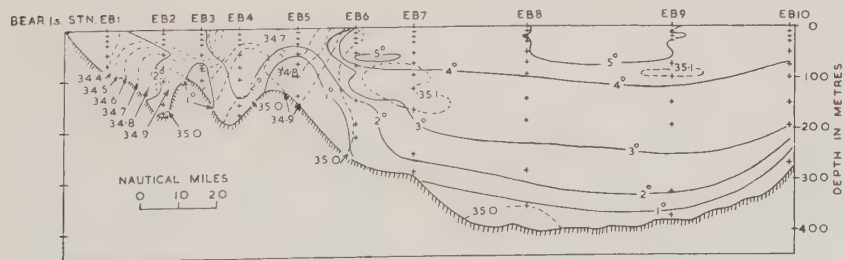


Figure 25. Temperature and salinity distributions on the East Bear Island section 28. September—1. October 1956.

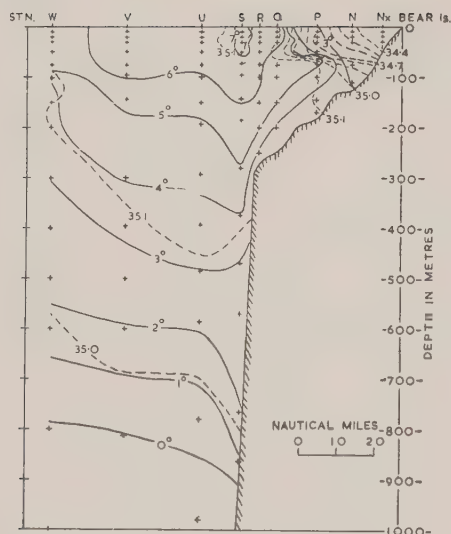


Figure 26. Temperature and salinity distributions on the West Bear Island section 22.—26. September 1956.

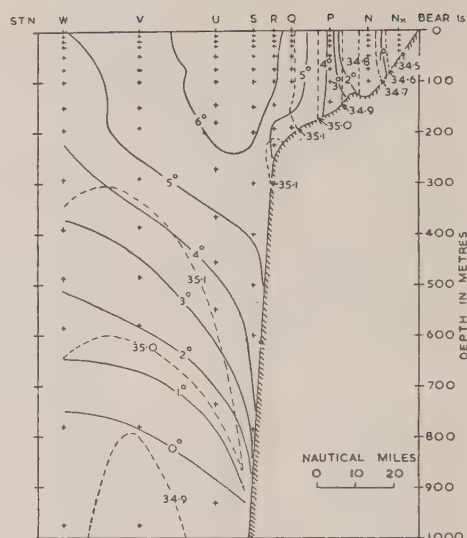


Figure 27. Temperature and salinity distributions on the West Bear Island section 3. December 1956.

March since 1949, with the exception of 1955, and this marked polar front has been a regular feature of the section in this position each year. The West Spitsbergen Current was peculiar in 1956 in the remarkably small amount of water with temperatures above  $4^{\circ}\text{C}$ . although the  $3^{\circ}$  isotherm was in approximately the same depth as in other years. The core of the current appeared to be closer to the bank than is usual during this month.

The Malangen, Fugløy—Bear Island, East and West Bear Island sections were not worked again until September, and the temperature and salinity distributions for this month are shown in Figures 23—26. On the Malangen section the temperature and salinity distributions are seen to be similar to those found in March in the deep water. Near the surface however, higher temperatures and salinities were found in the Atlantic water, and higher temperatures in the Norwegian coastal water due to summer warming. In the North Cape Current, as shown by the Fugløy—Bear Island section, high salinities extended to the bottom, in contrast to conditions in March, and arctic water lay over the Atlantic water near the Bear Island Bank. There was water above  $2^{\circ}\text{C}$ . on the shallow part of the bank to a depth of 75 m. even though colder water covered the bottom in the northern half of the channel. On the East Bear Island section the high salinity water was confined mainly to the Hope Island Deep while the arctic water lay over a mixture of arctic and Atlantic water in the South East Gullies, as on the Fugløy—Bear

Island section. The same conditions occurred on the bank to the west of Bear Island as shown by Figure 26, but otherwise the West Bear Island section was of the type expected at this time of year.

By December however, bottom temperatures on the West Bear Island section were the warmest at this season since February 1951, a temperature of  $3.94^{\circ}\text{C}$ . being recorded at Station S at a depth of 788 m. The isotherms were inclined steeply to the edge of the shelf as shown in Figure 27, indicating a high volume transport. Salinities were slightly higher than in February 1951, water of above  $35.1^{\circ}/_{00}$  being observed on the surface from Station Q to Station W and reaching down to about 800 m. at Station S.

Conditions in the North Cape Current are shown by the Fugløy—Bear Island section in Figure 28 to have been similar to those prevailing in September but about one degree cooler on the surface towards the Norwegian coast, where coastal water was found to be overlying the Atlantic water. On the East Bear Island section there was a large volume of water with a salinity greater than  $35.1^{\circ}/_{00}$  in contrast to the small amount observed in September and the low salinity water of the Bear Island Current was restricted to the immediate slopes of the bank as on the West Bear Island and Fugløy—Bear Island sections. Figure 30 shows the state of the North Cape Current off Vardø. Atlantic water lay beneath the coastal water at the southern end of the section and north of the Skolpen Bank flowed over

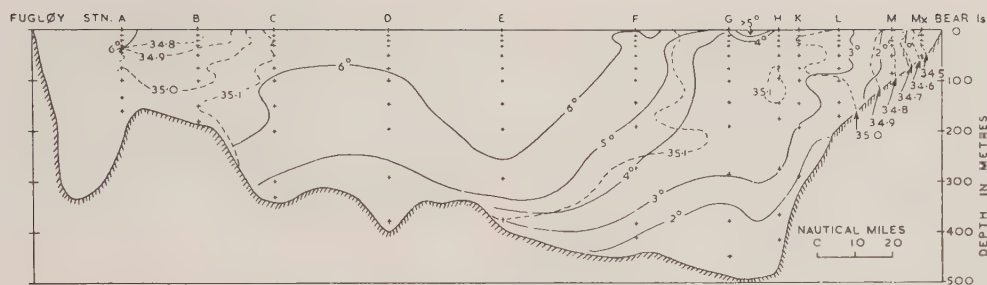


Figure 28. Temperature and salinity distributions on the Fugløy to Bear Island section 1.—3. December 1956.

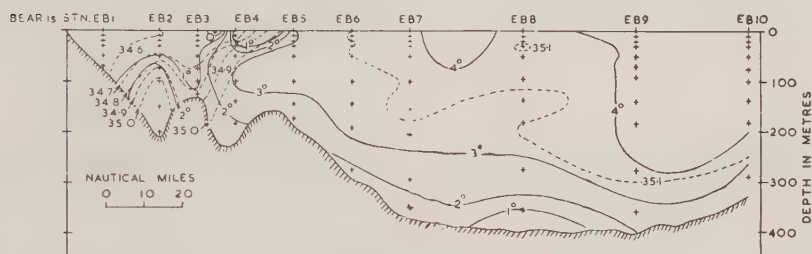


Figure 29. Temperature and salinity distributions on the East Bear Island section 4.—6. December 1956.

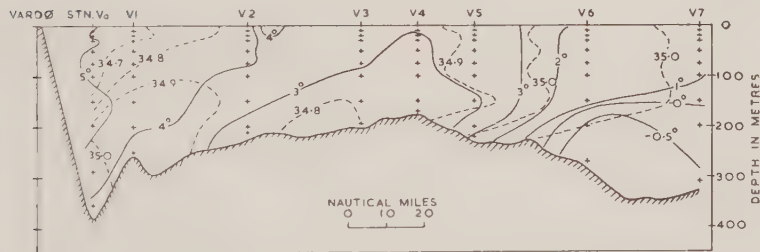


Figure 30. Temperature and salinity distributions on the Vardø to Eastern Basin section 11.—12. December 1956.

the cold water on the bottom of the Eastern Basin to impinge on the slopes of the Kanin Bank further east, as seen in Figure 31. The warm but low salinity water above the Skolpen Bank was part of the tongue stretching north-westwards from Cape Kanin which has already been mentioned.

The volume transport above 400 m. at Malangen in March between Stations M4 and M6 was calculated as 11.00 km.<sup>3</sup>/hr., using a reference level of 750 decibars. Across a slightly shorter distance in September (50 instead of 58 nautical miles) the volume transport was found to be 2.90 km.<sup>3</sup>/hr. On the West Bear Island section, Stations S

and W were worked in January, May, and July in addition to the occasions mentioned above when the section was worked in full. The 400 m. volume transport between these two stations for each cruise is given in Table 3. The transport shown for September is the mean of the replicate values obtained by working Stations S and W repeatedly and these ranged from -0.25 to 4.98 km.<sup>3</sup>/hr. The volume transport at the end of March, although exceeding the mean, was within the range found in September, and consequently cannot be considered significantly greater, whereas at Malangen the difference was more pronounced, suggesting that a greater volume



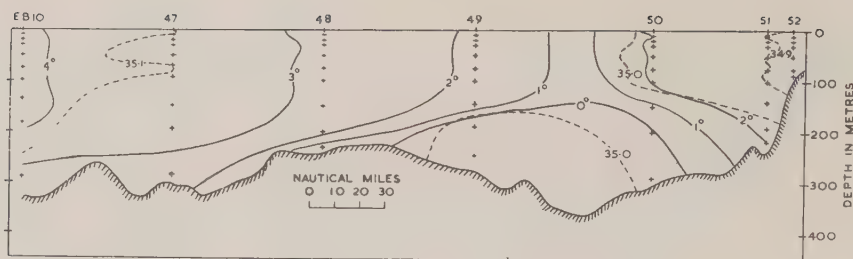


Figure 31. Temperature and salinity distributions on the Eastern Basin section 6.—7. December 1956.

### Note to Figures

Variations in the depth and position of stations on the temperature and salinity sections are due to the navigational difficulties experienced in the area.

Table 3. Volume transport above 400 m. during 1956:  
West Bear Island section

| 1956                         | Volume transported<br>in km. <sup>3</sup> /hr. |
|------------------------------|------------------------------------------------|
| 13.—14. January . . . . .    | 5.10                                           |
| 31. March—2. April . . . . . | 2.46                                           |
| 28.—31. May . . . . .        | 8.38                                           |
| 25. July . . . . .           | 3.04                                           |
| 23.—27. September . . . . .  | 1.82                                           |
| 3. December . . . . .        | 11.55                                          |

## Soviet Observations in the Norwegian, Greenland, and Barents Seas in 1956

(Table 4)

## Greenland and Norwegian Seas

To meet the requirements of the fishing industry, investigations were made into a) the characteristics of the water masses present, b) the laws governing the variation of these characteristics and their relation to meteorological factors, and c) the variation of the heat content in the separate branches of the Atlantic Current.

In 1956 oceanographic investigations were carried out by PINRO on board the ships "Professor Mesyatsev" and "Academician Berg" and by the Hydrometeorological Service in the R/V "Polyarny". Hydrological and biological observations were also made on board the Fisheries Reconnaissance Ships. The first-named ships (excluding the Reconnaissance Ships) carried out serial observations of temperature and salinity for the most part down to 500 m. depth. Stations were worked in the vicinity of fishery observations and along the standard sections, namely, across the Faroe-Shetland Channel (March, July, August), along latitude  $69^{\circ}20'N$ . (May and August), along  $71^{\circ}10'N$ . (May, August), and along  $74^{\circ}30'N$ . (April, July).

Observations of oxygen, phosphates, silicon, nitrites, and nitrates were made during the polar front surveys between Jan Mayen and the Louise Boyd seamount in the Faroe-Shetland Channel region and certain other standard sections. Fishery Reconnaissance Ships took water temperature measurements down to 200 m. depth on the fishing grounds. In addition, the Soviet fishery

of the Atlantic Current was diverted round the North Cape in March than in September. In early December the volume transport was calculated to be  $11.55 \text{ km}^3/\text{hr.}$ , which is of the same order as the highest ever recorded by the "Ernest Holt" in February 1951, ( $11.71 \text{ km}^3/\text{hr.}$ ). It is clear from the temperature and salinity sections for December that the reference level of 750 decibars does not correspond to the upper surface of the Norwegian bottom water, and hence this value of the volume transport must be regarded as a minimum estimate.

H. W. HILL

## Reference

- LEE, A. J. (1956). "Hydrographic Conditions in the Barents Sea in 1955". Ann. Biol., 12. Copenhagen, 1957.

research vessels made regular surface temperature observations on every cruise. The data so obtained were used for charts of temperature distribution on the fishing grounds.

Echo-soundings were made in the vicinity of the Mona Ridge and the Faroe-Iceland Ridge in the central part of the Norwegian Sea. In 1956 the greatest depth (4,487 m.) was found at 68°39.7'N., 02°54.5'W.

#### Barents Sea

The fisheries in the Barents Sea, one of the richest of northern fishing grounds, depend largely on demersal fish, most of which are known to spread eastwards into the region from the Atlantic and return westward for spawning. It has been found that variation in the inflow of Atlantic water into the Barents Sea influences the fishery; the rate at which the fish migrate eastward, the distribution, and their concentration in certain areas are all affected. Accordingly our programme of investigation of the biological productivity of the various water masses has included hydrological studies. Since oceanographic conditions in the Barents Sea depend considerably upon the inflow of warm water, it was natural that the investigations started many years ago into the variation of the heat content of the water in the Nordkapp branch of the North Atlantic Current and its effect on the productivity of the water masses should be continued.

In connexion with this, regular observations were carried out on five sections (see Table 4) by the Fisheries Reconnaissance Ships "A. Ot-kupschikow" and "Tobseda", and the research ship "Polyarnyk".

Observations of temperature, salinity, and in a number of cases, oxygen content were made on the sections at standard depths of 0, 10, 25, 50, 75, 100, 150, 200 m., etc. Weather observations were also made. Salinity was determined by the Mohr-

Knudsen titration method. To study the diurnal variation of temperature and salinity, observations were made at several stations at half-day intervals.

Systematic surface temperature measurements were made by the Soviet fishery research ships and by some merchant vessels. In the oceanographic laboratory of the Polar Institute of Marine Fisheries and Oceanography (PINRO), Murmansk, quarterly or annual reviews of hydrological conditions were based on the data obtained by the research ship and forecast of water temperature variations were made.

V. A. LEDNEV

#### Fluctuations of the Hydrographic Conditions in a Section across the Norwegian Current

(Figures 32 and 33)

The "Anton Dohrn" carried out a hydrographic profile in about 70°N. on 24. November 1956; this section, 70 miles long, was repeated on 1., 4., and 7. December in order to ascertain the variability of the temperature and salinity in the Norwegian Current. It soon became evident that a station interval of 5 miles was insufficient to show the true nature of the distribution. Accordingly, on the third repetition, the stations were spaced at 3-mile intervals (Fig. 32). The observations reveal that a system of internal waves is formed in the stratified ocean. In the present case the waves had a length of about 18 miles and a height of of about 100 m. The amplitude observed depends, however, on the phase at which one encounters the system. In the three other profiles, the wave height amounted to 200—300 m. near the edge of the continental slope. In them maximum elongation was probably obtained. The period of the phenomenon is not known, but it seems to be longer than tidal periods and it may be caused by atmospheric pressure disturbances, which were very intense and numerous at that time.

Figure 33 shows the shift of the 3° isotherm and the 35<sub>00</sub> isohaline near the surface for all four sections within this short period of time. The other isotherms changed similarly (see Fig. 32). As might be seen in the diagram at the antinodes the isotherms regularly shift about 200 m. in 3 days. In extended profiles, in which the waves are encountered at different phases, a very distorted picture is obtained even if measurements are

Table 4. Location and date of the sections

| No. | Section                               | Date                                                                        |
|-----|---------------------------------------|-----------------------------------------------------------------------------|
| 1   | Nordkapp—Bear Island                  | March, May, June,<br>October, December                                      |
| 2   | Bear Island—Sydkapp                   | July, August                                                                |
| 3   | Kola meridian                         | January, April, May,<br>June, August, Octo-<br>ber, November, De-<br>cember |
| 4   | 68°14'N., 39°51'E.—<br>71°N., 41°5'E. | January, March,<br>June, August, De-<br>cember                              |
| 5   | 71°N., 41°5'E.—<br>71°25'N., 40°32'E. | January, March,<br>June, December                                           |

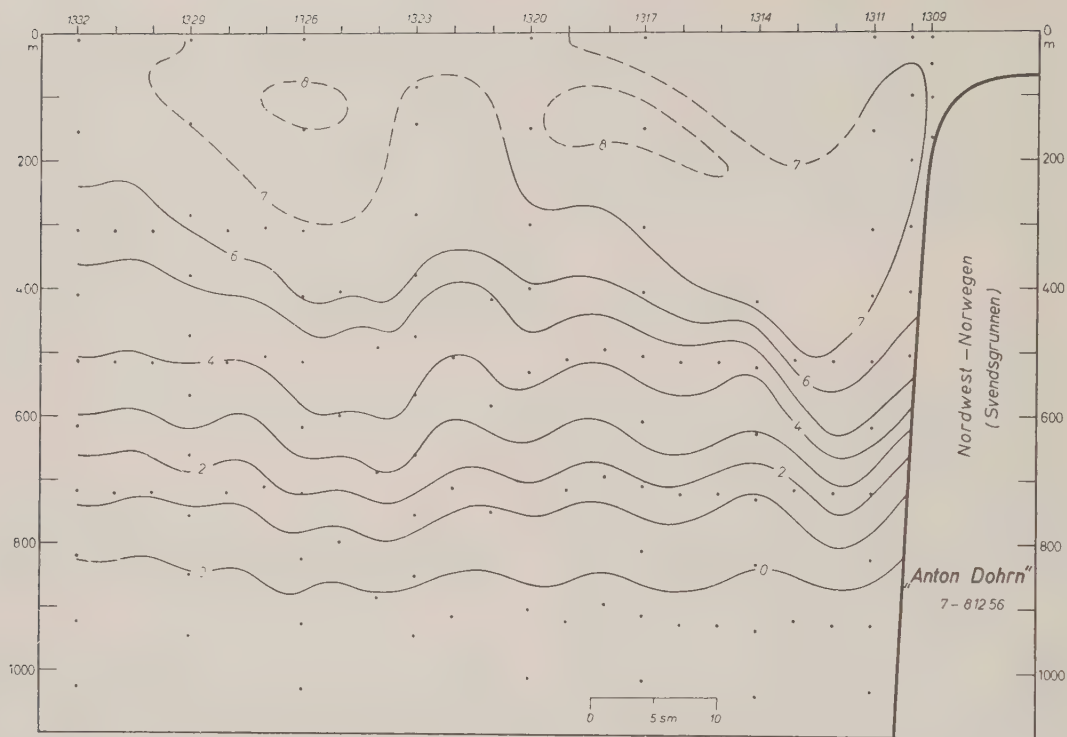


Figure 32. Distribution of temperature in a vertical section across the Norwegian Current in about  $70^{\circ}\text{N}$ .; station interval, 3 sea miles. The location of the profile (I) is shown in the chart in Fig. 33.

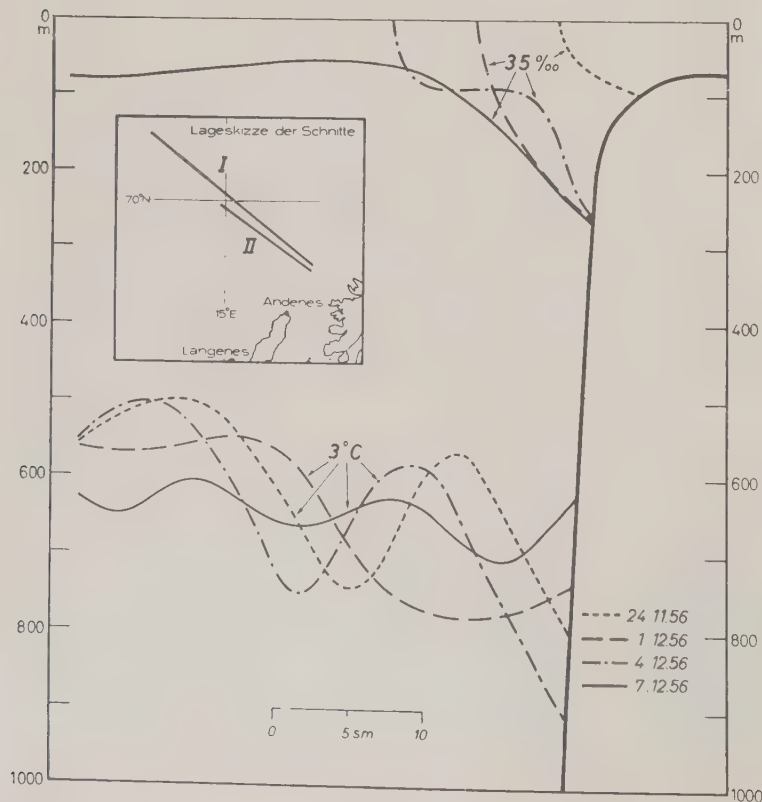


Figure 33. Fluctuations of the  $3^{\circ}\text{C}$  isotherm and the  $35^{\text{‰}}$  isohaline in the Norwegian Current at  $70^{\circ}\text{N}$ . between 24. November and 7. December 1956. The location of the profile (II) is shown in the chart.



carried out at short distances apart. Profiles with station intervals of more than 5 miles would not represent the real situation and the picture obtained would very much depend on the accidental position of the stations. The diagram demonstrates that an instantaneous survey of the hydrographic conditions would not necessarily be a just representation (certainly not if the distance between the stations were large), and that short-period fluctuations can be greater than seasonal ones.

The changes near the surface are well shown by the position of the 35‰ isohaline. The position of this isoline, which indicates the boundary between coastal and Atlantic water, is strongly influenced by what is happening in the depths. The periodic currents connected with the internal waves transport the coastal water far away from the shelf or pump it back to it. It is especially noteworthy that the dimensions of this process far surpass expectation.

In the open ocean the pulsations connected with the internal waves observed appear to be many times greater than those caused by the surface tides. A relation ship seems to exist between wave phase and catches on the fishing grounds in this locality.

W. KRAUSS

## Hydrographic Conditions North and East of Iceland 1956

(Figures 34–38)

From 20. May to 17. June the Icelandic research vessel "Ægir" carried out a hydro-biological survey in the waters west, north, and east of Iceland.

The location of the stations worked is shown in Figure 34. The black dots indicate hydrographic stations, the circles BT stations, and the crosses some of the stations worked by the Faroese inspection vessel "Ternan". The temperature data from these stations were kindly placed at the author's disposal by Mag. JOENSEN.

The distribution of temperature and salinity at various depths is shown in Figures 34–36. Off the west and south-west coasts, the temperature in the uppermost 100 metres was about normal, or slightly below. In June this year, the drift-ice was much nearer the north coast of Iceland than in the two preceding years. Because of the ice conditions, the temperature in the surface layers along the north coast was somewhat lower than in June 1954 and 1955, but this difference may be due partly to the difference in time, as this year's investigations were carried out about a week or two earlier in the season. For the rest of the summer, similar ice conditions prevailed.



Figure 34.

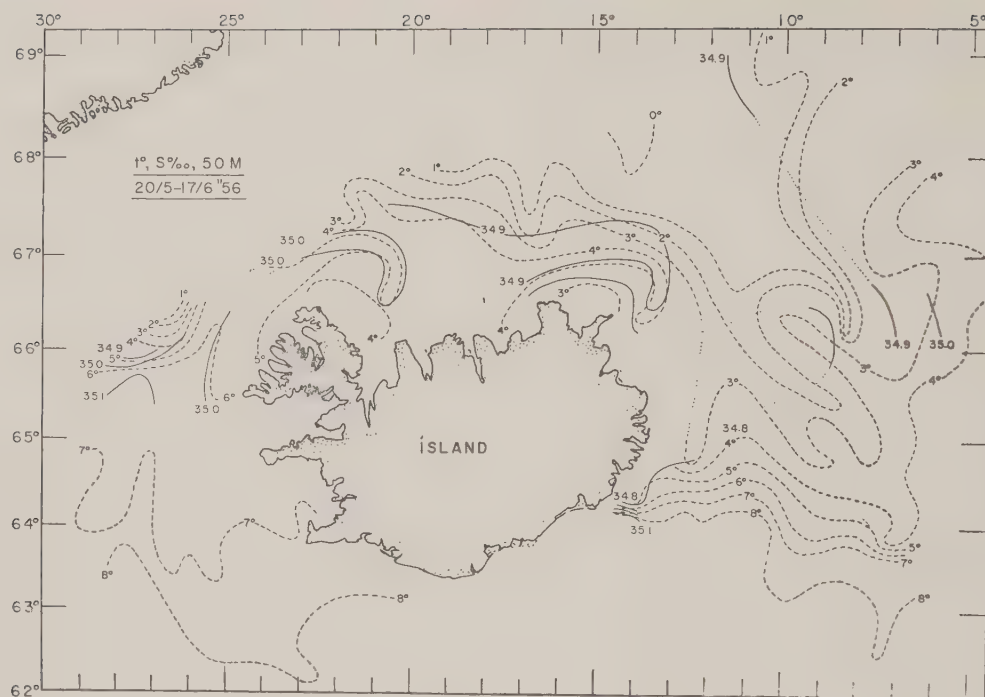


Figure 35

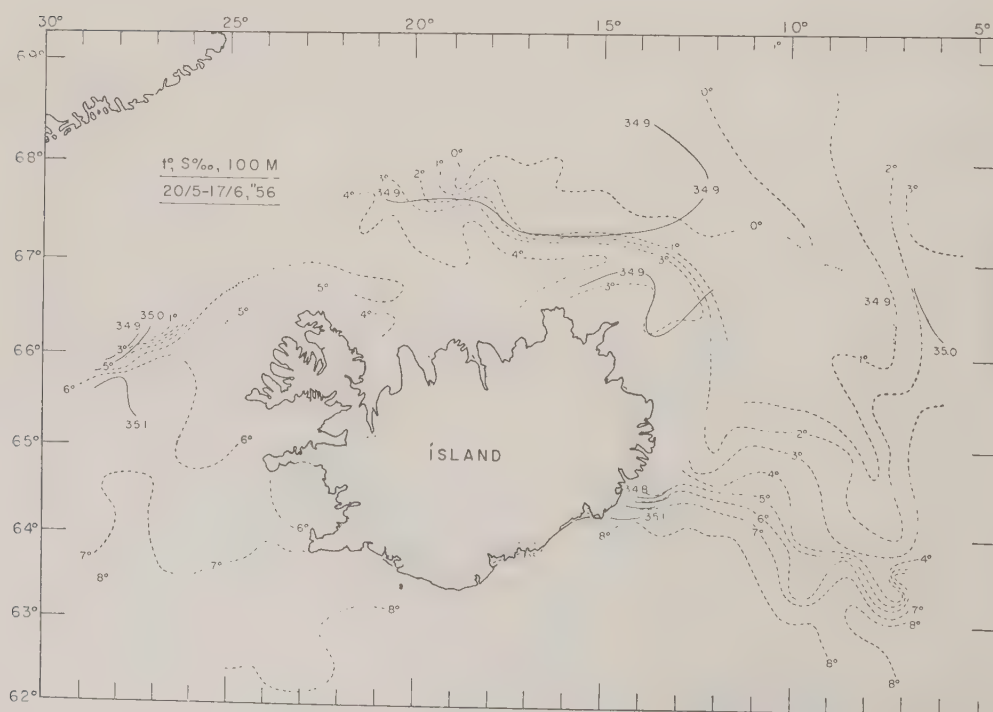


Figure 36.

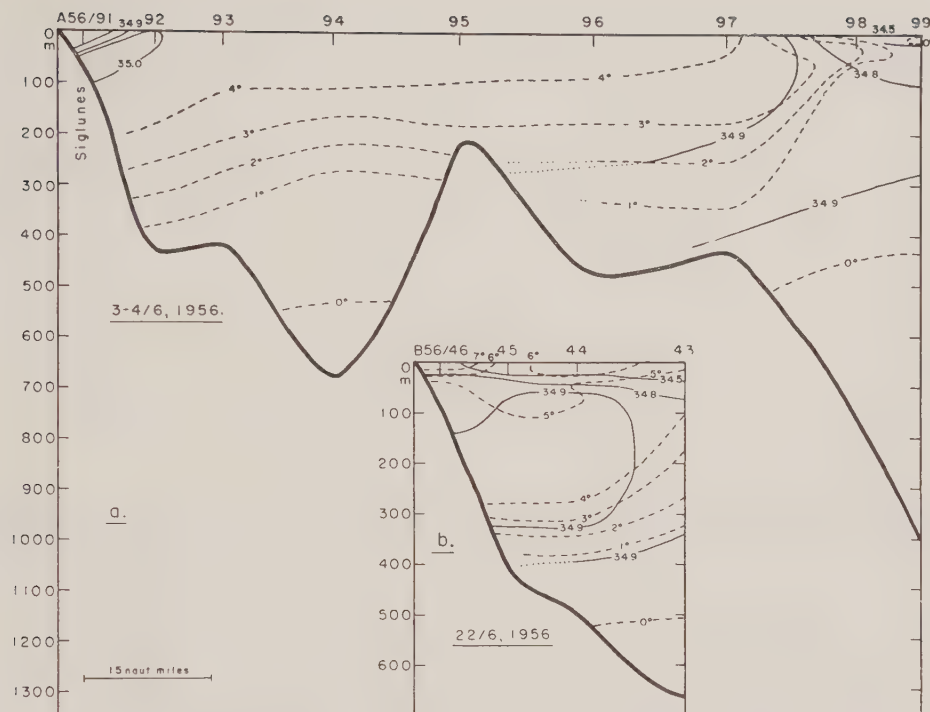


Figure 37. Section off Siglunes.

a, early June; b, late June 1956.

In the oceanic area, between north-east Iceland and Jan Mayen, the temperature at 20 metres in June this year was similar to that in 1955 or even higher. East of Iceland, however, the temperature at this depth was somewhat lower than in the preceding years.

At 50 metres the temperature was relatively higher than that in the surface layers, as a thermocline had not been formed. In the western part of the North Icelandic coastal area, the temperature was somewhat lower than last year, but in the eastern part it was about the same, or rather higher. However, in the oceanic area, north-east of Iceland, the temperature and salinity were higher than normally observed and the tongue of cold water less apparent. The boundaries between the arctic and Atlantic water east of Iceland seemed less sharp than in preceding years and the western tongue of the East Icelandic Current less conspicuous. Similar features were indicated at 100 metres depth. In general the Atlantic water had a greater extension than last year and the area covered by cold arctic water was smaller. At 100 metres a westerly branch of the East Icelandic Current can hardly be noticed.

In the section off Siglunes on the north coast (Fig. 37), the temperature in the surface layers in early June was decidedly lower than about two weeks later in preceding years, and a thermocline had not been formed. In the deeper layers, the temperature was similar to that of last year or slightly lower. The amount of Atlantic water ( $S > 35.0\text{‰}$ ) off Siglunes was distinctly less than normally observed at this time of the year. In the northernmost part of the section, near  $68^\circ\text{N}$ ., polar water was observed at about the same distance from the coast as in 1955. When observations were repeated later in the month (Fig. 37 b), the temperature had increased in the surface layers as well as at subsurface depths, and a weak thermocline was present. However, the salinity was decidedly lower than normal, most likely because of the nearness of the drift-ice.

Figure 38 illustrates the section running north-eastward of Langanes. Except for lower surface temperatures and the absence of a thermocline in the coastal area, the temperature was somewhat higher at subsurface levels between 50 and 300 metres than was found two weeks later last year. Outside the coastal area, the temperature



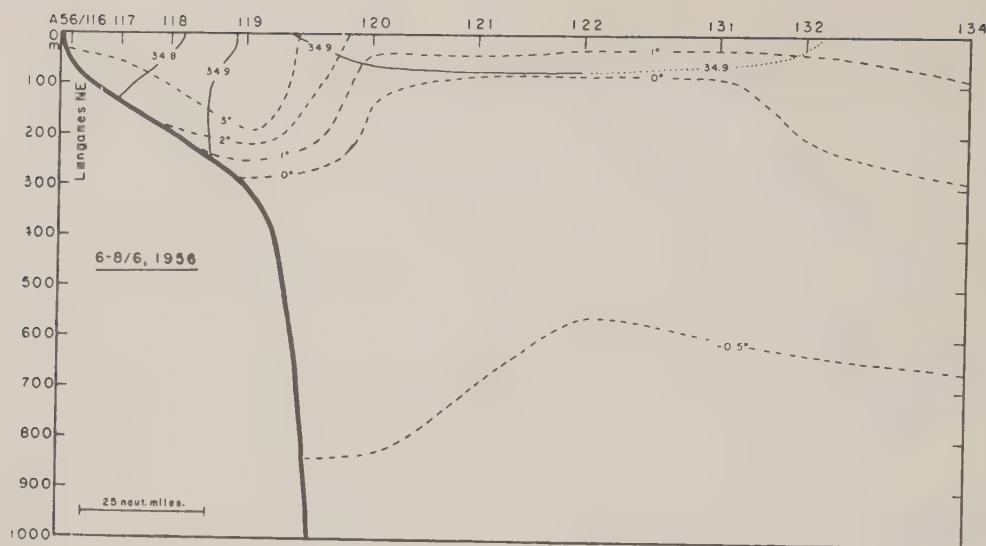


Figure 38. Section north-east of Lānganes.

was 1–2°C. in the surface layers, but no definite thermocline existed and temperatures below 0°C. were not found at depths less than 100 metres. In the intermediate layers, below the 100 m. level, the minimum temperature was about -0.4°C., which is decidedly higher than has been observed in this section for many years. The salinity in the upper layers was also found to be higher. *It must be concluded that the amount of polar water in the region east and north-east of Iceland in June this year was much less than normally observed in recent years.*

UNNSTEINN STEFÁNSSON

### Hydrographic Conditions in Icelandic Waters August/September 1956

(Figures 39 and 40)

The Scottish research vessel "Explorer" made a survey of Icelandic waters in August/September 1956. Figure 39 shows the extent of the survey and the distribution of surface temperature and salinity; Figure 40 depicts the dissolved oxygen and free phosphate concentrations at 10 m. depth.

Atlantic water of salinity 35.00‰ and above, associated with the 10°C. isotherm, penetrated the Anarfiörður section (stations 30–34) at one station only, No. 32. Water of salinity above 35.00‰ could be followed as bottom water below 75 m. depth at stations 27 and 28. At station 25 a trace of it was observed at 100 m. At these stations the water of salinity greater than 35.00‰ was associated with

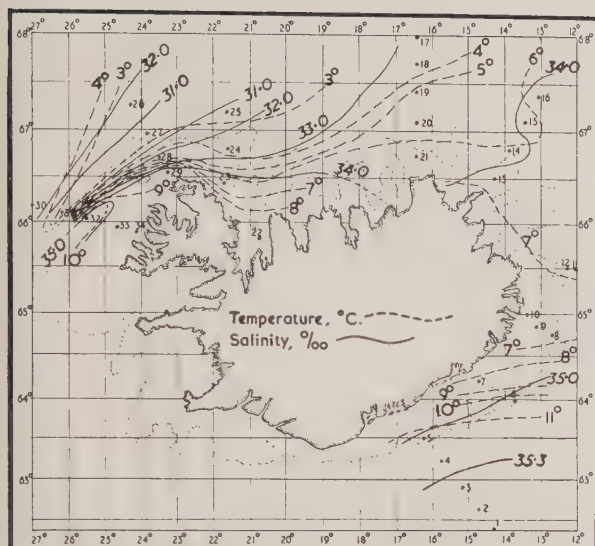
temperatures between 6° and 7°C. In the Melrakasljetta (stations 17–21) and Lānganes sections (stations 13–16) no evidence of Atlantic water was found.

There was penetration of polar water of salinity 31‰ at stations 22 and 31. North of Iceland, the extent of polar water, which became progressively mixed as it spread eastwards, is indicated by the 7.5 cc./l. isoline for dissolved oxygen in Figure 40, and a corresponding salinity value of ca. 33.5‰.

In the south-east the 35‰ isohaline was again associated with the 10°C. isotherm. At station 7 water of salinity greater than 35.00‰ was observed at the bottom with a temperature of 8°C.

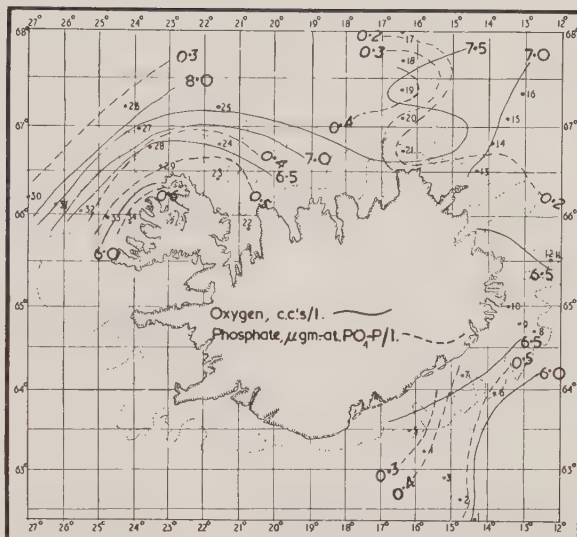
Intermediate arctic water, typified by zero temperature and below, and a salinity of ca. 34.0‰ was sampled below the 300 m. contour line of the island declivity in the two sections made in the north-east, and extended to depths below 150 m. at stations 17 and 16. In the Kögur section it was found at 400 m. depth at station 26, while in the Anarfiörður section it occurred near the bottom (600 m.) at station 30. This water was further characterized by a uniform phosphate content of 0.9 µg.-at. PO<sub>4</sub>-P/l. and an oxygen saturation value of 88–90%.

The highest phosphate values at 10 m. were associated with Atlantic water. In the south-east at stations 1 and 6 a value of 0.5 units extended to the 50 m. depth. At the 100 m. level at station 1, and at similar depths at many stations on the shelf the nutrient value was greater than 1.0 units. In the north-west similar phosphate values were



TEMPERATURE &amp; SALINITY, Surface. 30.8.56-7.9.56.

Figure 39. Temperature and salinity, surface, 30. August to 7. September 1956.



DISSOLVED OXYGEN &amp; FREE PHOSPHATE, 10m. 30.8.56-7.9.56

Figure 40. Dissolved oxygen and free phosphate, 10 metres, 30. August—7. September 1956.

observed. The lowest value of 0.11 units at 10 m. depth was found at stations 16 and 17. The stability of the water column at these stations and the admixture of polar water could account for this depletion. In the north-west, water in contact with the shelf and at 100 m. depth at stations over the island slope, had a phosphate value slightly greater than 1.0 units with an oxygen saturation value of 96—97%. The temperature of this enriched water ranged from 5°C. down to 1°C. and the salinity was about 34.8‰. These characteristics, together, help to distinguish this layer from intermediate arctic water which occurs at slightly greater depths.

Throughout most of the area surveyed the water at 10 m. was supersaturated with respect to oxygen. In the south and south-east the value ranged from 102—103%, where phosphate values lay between 0.4—0.5 units, and up to 107% where the phosphate value was lower. In the north and north-west, values for oxygen saturation lay below 103 to 107% in association with lower phosphate values, and 98% at the two inshore stations 34 and 23 where phosphate values were the highest. At 30 m. and below the saturation was less than 100%, except at stations 16 and 24, the outermost stations of two sections, where it was 104%.

R. B. BURNS

### The Oceanic Polar Front in the Waters round Greenland and Iceland in August 1956

(Figure 41)

In completion of the investigations made by the "Anton Dohrn" in these waters<sup>1)</sup> in June 1955 an examination was made by the "Gauss" during her special survey work, of the distribution of temperature and salinity at the surface. Observations were made at 472 positions from 30. July to 28. August 1956. The results are shown in Figure 41. They can hardly be called synoptic, owing to the length of the cruise. The sections, however, were run continuously from west to east, therefore parts of the whole region are nearly crossed synoptically. Four typical phenomena may be distinguished: —

1) The limit between the cold East Greenland water, poor in salinity, and the warm Atlantic water with high salinity — the so-called polar front — is very narrow.

2) The course of the polar front based on temperature and salinity is identical.

3) The course of the polar front shows great meanders.

4) These meanders are situated in the cross-channel of the Greenland-Iceland Ridge, recognizable by the course of the 500 m. depth line, and

<sup>1)</sup> G. DIETRICH, 1957. Ber. Deutsch. Wiss. Komm. Meeresforsch., 14 (3).

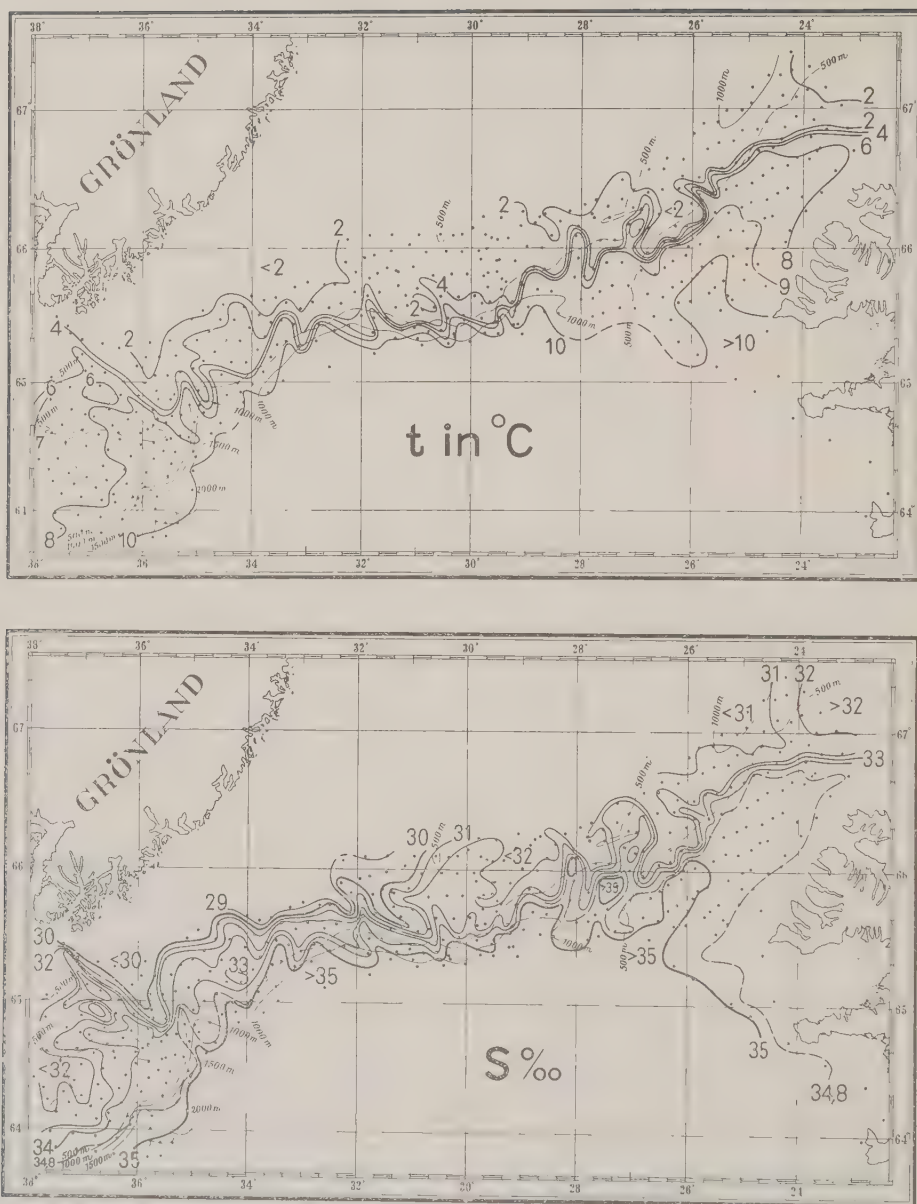


Figure 41. Temperature and salinity at the surface in Greenland-Iceland waters in August 1956 during the survey of the "Gauss".

follow in their main direction the edge of the Greenland Shelf.

It is to expect that the meanders are wandering, in correspondence with the East Greenland Current. Combined with this process the hydrographic conditions on the fishing grounds will fluctuate very strongly.

G. DIETRICH

#### Sections Faroes to East Greenland and Cape Farewell to Western Ireland

(Figures 42-44)

Two trans-Atlantic sections were worked with R/V "Dana", the section along 62°N. from the Faroes to East Greenland, 28. June to 7. July, (Fig. 43) and from Cape Farewell to Ireland, 1. to 10. August, (Fig. 44).



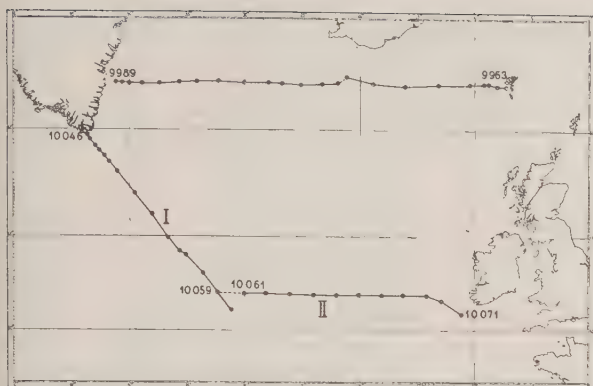


Figure 42. Location of sections.

In the eastern part of the Faroe-Greenland section a thicker layer of warm Atlantic water was observed than at any time since 1948. The temperature of the water between the Faroes and the Reykjanes Ridge which had fallen until 1951 has since increased.

Over the slope west of the Faroes a thin layer of very cold water was found, which must have originated from the depths of the Norwegian Sea, and flowed over the ridge between the Faroe Bank and the Faroes, or the Faroe-Iceland Ridge.

West of the Reykjanes Ridge the north-going Irminger Current was present. This current seemed well developed. Off East Greenland we found the south-going part of the Irminger Current outside the East Greenland Polar Current. Only small quantities of Atlantic water were present in the western part of the Irminger Sea.

In the deeper part of the Irminger Sea there was a thick layer of cold bottom water. The steeply sloped isotherms indicated that it was flowing southward at a considerable rate. This cold water must have consisted of deep water from the Norwegian Sea, which had overflowed the Iceland-Greenland Ridge. This is the water which eventually forms the bottom water over a great part of the northern North Atlantic.

On section I, south-eastwards from Cape Farewell, the extension of the East Greenland Polar Current was found to be considerably smaller than in 1955. The Irminger Current, on the other hand, was better developed than in 1955. The front between the cold subarctic water from the Labrador Sea and the warm "Gulf Stream" water was found at its usual position in the vicinity of  $51^{\circ}30'N.$ ,  $32^{\circ}30'W.$  but it did not appear to be as sharp as usual.

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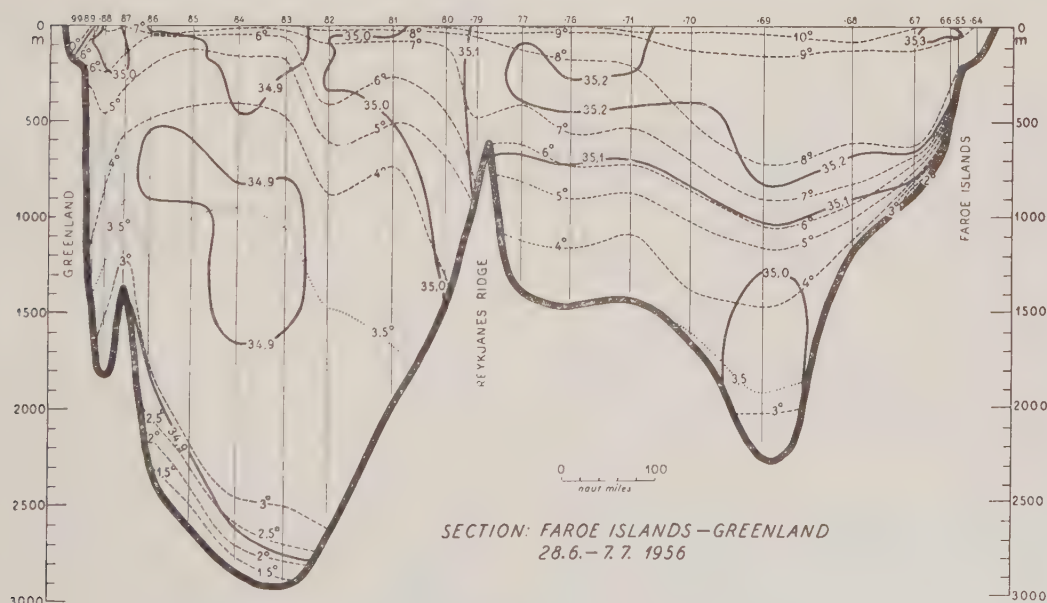


Figure 43. Section from the Faroes to East Greenland along  $62^{\circ}N.$ , 28. June—7. July 1956.

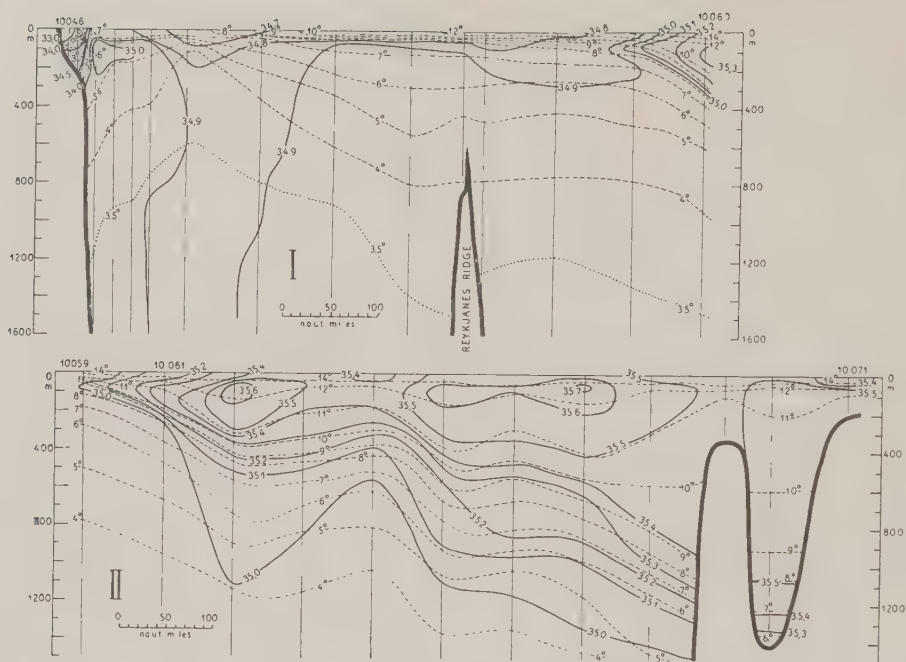


Figure 44. Sections from Cape Farewell to Ireland, 1.—10. August 1956.

### Hydrographic Conditions in West Greenland Waters 1956

(Figures 45-53)

As in previous years hydrographic observations were carried out in the fjords and coastal regions by M/C "Adolf Jensen" and M/C "Tornaq" and in the Labrador Sea and Davis Strait by R/V "Dana". Figure 45 shows the location of the sections and the distribution of temperature at 50 metres. The hydrographic conditions are further illustrated in Figures 46—51.

There was almost no "stor-is" in West Greenland waters in July 1956 and the temperatures in the polar component of the West Greenland Current were not very low. Only on the southernmost section was a trace of water with negative temperatures found.

The Atlantic component of the current was well developed and great quantities of warm water were being carried up along the western slope of the banks. Northwards to Lille Hellefiske Bank the water layer with temperatures over 4°C. was thicker than for many years past.

The boundary of the arctic Baffin Land Current was found to be further east than usual, especially so on the section off Lille Hellefiske Bank (section IV). This also was the case with the boundary of the "vest-is".

A section over Fylla Bank worked by the "Adolf Jensen" on 23. April showed that there was no water with negative temperatures either over the shallow part of the bank or over the edges of the bank. This indicates that the winter cooling had been less severe than usual, which is in accordance with the fact that the winter was very mild.

When the section was repeated on 5. June the temperature over the shallow part of the bank had increased only to 0.8°, which is considerably below normal. This low temperature is thought to be due to low air temperatures in May and June and is possibly the main reason for the very few cod larvae caught in the summer of 1956.

In July, temperatures over the shallow parts of the banks were about normal south of Store Hellefiske Bank; on this bank itself, temperature was a trifle below normal.

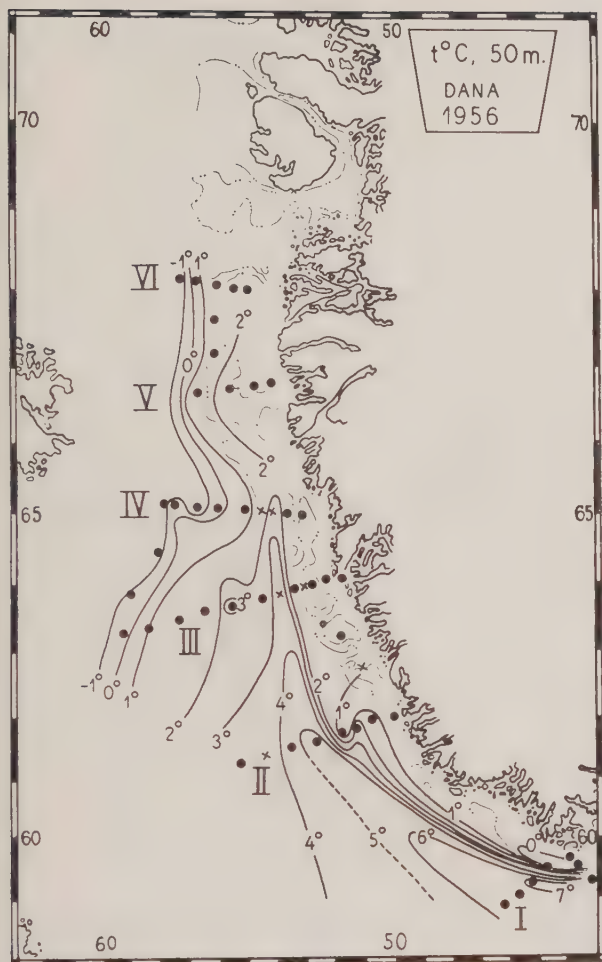


Figure 52 shows the phosphate distribution at 20 metres as observed on the "Dana" cruise. The essential features were the same as in previous years, with one maximum near the banks off south-west Greenland and another on the boundary of the Baffin Land Current. Over the Store Hellefiske Bank the phosphate concentration was somewhat higher than usual.

A fixed station at the entrance to Godthåb Fjord was worked 12 times during 1956. The variation of temperature at this station from October 1955 to January 1957 is shown in Figure 53. In most years an inflow of warm and saline bottom water takes place in November–December, and this occurred in 1956; the maximum bottom temperature exceeded 4°C., which is higher than in 1954 and 1955. An additional inflow of warm water occurred in February, which is quite extraordinary.

The effect of winter cooling was less pronounced than in the two previous years. No temperatures below zero were measured below 50 metres. In 1954 and 1955 temperatures below -0.5°C. were found from surface to bottom in March.

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Figure 45. Location of stations and distribution of temperature at 50 metres.

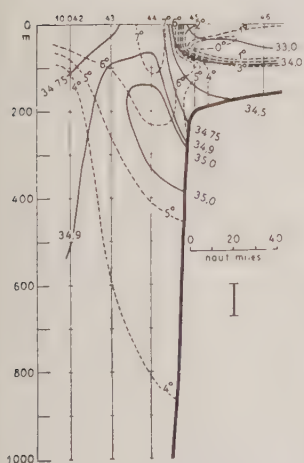


Figure 46. Section I off Cape Farewell, 1.—10. August 1956.

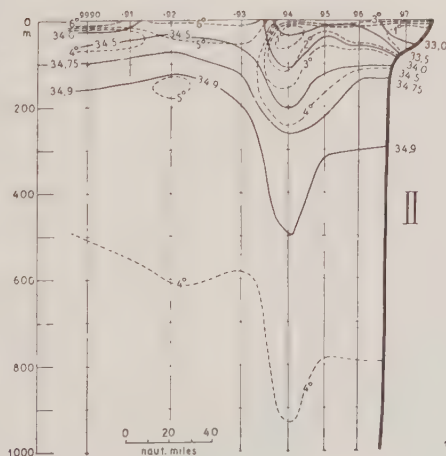


Figure 47. Section II off Frederiks håb, 10.—11. July 1956.

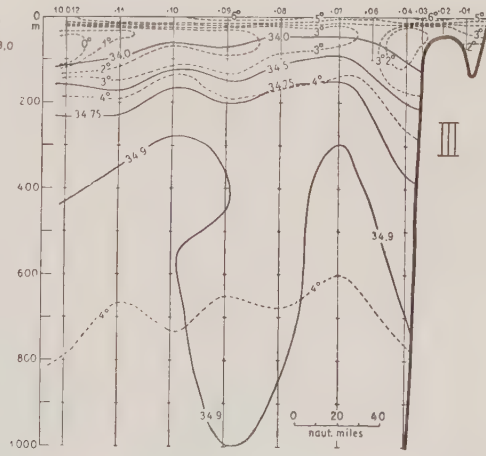


Figure 48. Section III off Fylla Bank, 16.—18. July 1956.



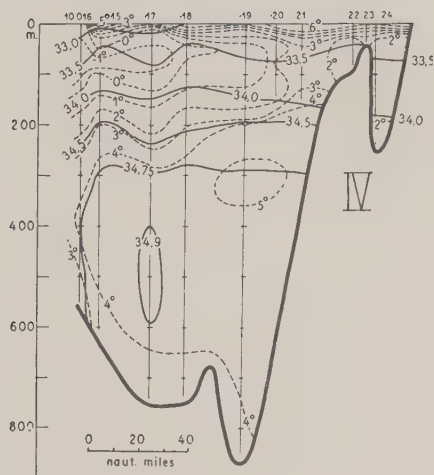


Figure 49.  
Section IV across Lille Hellefske Bank,  
19.-20. July 1956.

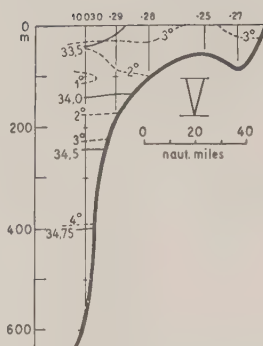


Figure 50.  
Section V off Holsteinsborg,  
21.-24. July 1956.

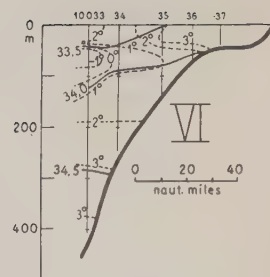


Figure 51.  
Section VI off Egedesminde,  
23.-24. July 1956.

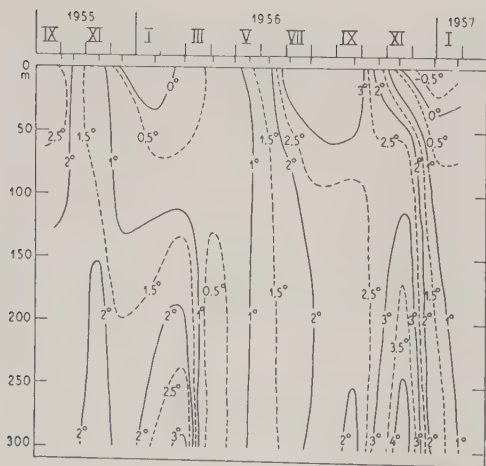


Figure 53. Variation of temperature at the entrance to  
Godthåb Fjord (64°07'N., 51°53'W.).



Figure 52. Distribution of phosphate, July 1956.

## Plankton

Dry Weight of Plankton in the Western Barents Sea  
1953—1956

(Figure 54; Tables 5-7)

Since the previous report (CORLETT, 1953) the area of the plankton sampling from the "Ernest Holt" has been extended and the method of collection changed slightly. Figure 54 shows the lines of stations that have been worked at various times from 1953 to 1956. Each line has between 4 and 10 stations, not all of which are worked on each cruise because of limitations of weather, ice, and time. Number 9 in Figure 54, represents sampling on the banks and over deep water west of Spitsbergen. The net used is a Hensen type net of No. 3 bolting silk with a mouth opening of  $\frac{1}{8}$  square metre. It is hauled vertically from the bottom to the surface, or from 600 metres to the surface when the bottom is deeper than 600 metres. The samples are dried and weighed as described by WIMPENNY (1949).

The results are presented in Tables 5 and 6 as dry weight of plankton in grammes under 1 square metre. For each line on each cruise the mean of the separate stations is taken. The cruise means in the

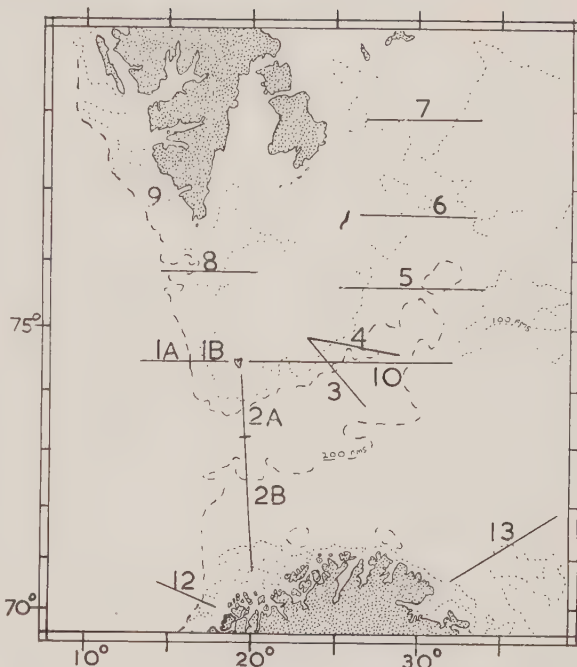


Figure 54. Lines of plankton stations worked by R/V "Ernest Holt" between 1953 and 1956.

Table 5. Dry weight of plankton in g. under 1 square metre

(Figures in brackets are means of 2 stations only)

|      | Line              | 1A     | 1B     | 2A     | 3      | 4      | 5      | 6    | 7    | Mean |
|------|-------------------|--------|--------|--------|--------|--------|--------|------|------|------|
| 1953 | March             | (2.0)  | 1.7    | (3.1)  | (6.9)  | —      | (7.2)  | —    | —    | 4.2  |
|      | April             | —      | —      | 3.5    | 3.8    | —      | 2.7    | —    | —    | 3.3  |
|      | May               | 29.8   | 10.6   | 6.9    | 5.1    | 5.5    | 5.6    | —    | —    | 10.6 |
|      | July              | —      | —      | —      | 13.1   | (11.1) | 12.5   | —    | —    | 11.0 |
|      | August—September  | 9.5    | 6.1    | 11.1   | —      | —      | 9.4    | 10.5 | 10.4 | 9.5  |
|      | October           | —      | —      | 4.1    | —      | —      | 5.7    | 7.6  | 6.9  | 6.1  |
|      | November          | 4.4    | 4.1    | —      | —      | —      | —      | —    | —    | 4.2  |
|      | Line              |        |        |        |        |        |        | 8    | 9    |      |
| 1954 | February          | (4.6)  | —      | 3.4    | —      | —      | —      | —    | —    | 4.0  |
|      | March             | 5.5    | 1.8    | —      | 5.0    | —      | —      | —    | —    | 4.1  |
|      | May               | 22.0   | 5.8    | 4.6    | 6.5    | 6.9    | —      | —    | —    | 9.2  |
|      | June              | (16.5) | 10.6   | 16.7   | 18.7   | —      | 17.3   | —    | —    | 16.0 |
|      | August            | (9.4)  | (20.9) | 17.7   | —      | —      | —      | 12.2 | 30.9 | 18.2 |
|      | October           | 11.4   | 9.4    | 21.1   | 8.7    | —      | 26.7   | —    | —    | 15.5 |
|      | November—December | 5.5    | 5.2    | (14.9) | 18.8   | —      | (17.4) | —    | —    | 12.4 |
| 1955 | March             | —      | —      | 3.1    | (12.4) | —      | —      | —    | —    | 7.8  |
|      | April             | 6.6    | 4.5    | 3.4    | —      | —      | —      | —    | —    | 4.8  |
|      | June              | —      | —      | 2.8    | —      | —      | —      | —    | —    | 2.8  |
|      | July              | —      | —      | 8.6    | —      | —      | —      | —    | —    | 8.6  |
|      | September         | (8.2)  | 10.2   | 14.0   | —      | —      | —      | 17.9 | 11.2 | 12.3 |
|      | November          | —      | —      | 7.0    | —      | —      | —      | —    | —    | 7.0  |
|      | Line              |        |        |        | 10     |        |        |      |      |      |
| 1956 | March—April       | —      | 10.2   | 2.7    | —      | —      | —      | —    | —    | 6.5  |
|      | May—June          | (14.6) | 5.3    | 3.7    | —      | —      | —      | —    | —    | 7.9  |
|      | July—August       | (12.0) | 6.6    | 9.2    | —      | —      | —      | —    | —    | 9.3  |
|      | September         | 9.2    | 7.7    | 14.1   | 12.6   | —      | —      | —    | —    | 10.9 |
|      | December          | 5.2    | 3.8    | 14.7   | 13.9   | —      | —      | —    | —    | 9.4  |

Table 6. Lines in south-western Barents Sea  
Dry weight in g. under 1 m<sup>2</sup>.

|                     | 12  | 2 B   | 13   |
|---------------------|-----|-------|------|
| 1955 November ..... | —   | (1.4) | —    |
| 1956 March .....    | 4.7 | —     | —    |
| September .....     | 8.4 | 13.8  | —    |
| December .....      | —   | 5.9   | 10.7 |

last column of Table 5 are the means of the figures for each line. Table 6 gives a few records from the south-western Barents Sea.

From Table 5 it will be seen that the number of stations worked and the area covered varied considerably from year to year. Nevertheless the year 1954 stands out as one with high standing crop, particularly in summer and autumn. This is brought out when the means of the cruise means are taken for the three summer cruises between May and September each year:—

|                    | 1953 | 1954 | 1955 | 1956 |
|--------------------|------|------|------|------|
| g./m. <sup>2</sup> | 10.4 | 14.5 | 7.9  | 9.4  |

In the 1953 report the standing crop was reported as mg./m.<sup>3</sup> for hauls from 50 or 100 metres to the surface at stations on lines 1A, 1B, and 2A. So that a comparison can be made with the previous years, Table 7 gives the dry weight on these lines in the same units, but for the hauls from the bottom or 600 metres: the average depth sampled is about 300 metres. Direct comparison between the two sets of years is difficult because the zooplankton is not evenly distributed in the water column and is mostly concentrated in the upper layers in summer. Some hauls were made from 50 or 100 metres to the surface in 1954 and these gave means of 130 mg./m.<sup>3</sup>.

Table 7. Stations west and south of Bear Island

|                             | Number<br>of stations | Dry weight<br>mg. per m. <sup>3</sup> |
|-----------------------------|-----------------------|---------------------------------------|
| <b>1953</b>                 |                       |                                       |
| 16.—20. April .....         | 3                     | 11                                    |
| 20.—30. May .....           | 8                     | 43                                    |
| 25. August—9. September ... | 11                    | 24                                    |
| 9.—23. October .....        | 2                     | 14                                    |
| <b>1954</b>                 |                       |                                       |
| 17.—30. March .....         | 10                    | 10                                    |
| 15.—18. May .....           | 11                    | 31                                    |
| 16.—30. June .....          | 13                    | 52                                    |
| 14.—26. August .....        | 7                     | 55                                    |
| 8.—10. October .....        | 10                    | 45                                    |
| <b>1955</b>                 |                       |                                       |
| 14. March .....             | 4                     | 13                                    |
| 21.—30. April .....         | 12                    | 14                                    |
| 11.—12. June .....          | 4                     | 10                                    |
| 15.—16. July .....          | 4                     | 31                                    |
| 20.—21. September .....     | 9                     | 42                                    |
| <b>1956</b>                 |                       |                                       |
| 31. March—1. April .....    | 8                     | 40                                    |
| 28. May—11. June .....      | 8                     | 26                                    |
| 25. July—7. August .....    | 9                     | 30                                    |
| 22.—26. September .....     | 11                    | 30                                    |

in May and 190 mg./m.<sup>3</sup> in June. In the earlier report means were given for the cruises between mid-April and the end of September for the years 1949 to 1952: these are repeated here with means for the same seasons derived from Table 7:—

| Year       | mg./m. <sup>3</sup> |                              |
|------------|---------------------|------------------------------|
| 1949 ..... | 47                  | Depth 100 or 50 metres       |
| 1950 ..... | 54                  |                              |
| 1951 ..... | 15                  |                              |
| 1952 ..... | 22                  |                              |
| 1953 ..... | 26                  | Average depths<br>300 metres |
| 1954 ..... | 46                  |                              |
| 1955 ..... | 24                  |                              |
| 1956 ..... | 29                  |                              |

These figures confirm those derived from Table 5 in showing that 1954 was a year of high standing crop, comparable to 1950 and 1949, and probably exceeding them when allowance is made for the difference in depth sampled. The figures of volume transport for the West Spitsbergen Current given by LEE and HILL (in press) show that 1954 was a year with an abnormally high oceanic incursion into the western Barents Sea. HILL (p.26) says that December 1956, which showed high standing crop south and east of Bear Island, also had a high volume transport.

The figures in Table 5 also confirm the conclusion in the earlier report that the maximum standing crop over deep water (line 1A) occurs earlier in the summer than that in the shallower water over the bank (lines 1B and 2A).

JOHN CORLETT

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- LEE, A. J., & HILL, H. W., 1958. "The effect of wind on water transport in the region of the Bear Island fishery." *Proc. Roy. Soc., Ser. B.* (in press).
- WIMPENNY, R. S., 1949. "The dry weight and fat content of plankton." *Ann. Biol.*, 4 (1947): 89—90.

#### Plankton Survey from the Norwegian Sea in 1956 (Table 8)

In connexion with the newly developing drift-net fishery for herring, the Knipovich Polar Institute of Marine Fisheries and Oceanography carried out a series of plankton surveys in the Greenland and Norwegian Seas during the decade 1947—1956.

Part of the work has been reported on in Vol. IX of "Trudy VNIRO". Much space is given to the descriptions of the simultaneous oceanographic surveys in June 1954 and 1955, when plankton hauls were made simultaneously over the whole Norwegian Sea. These surveys showed considerable differences between plankton development and distribution in different years.



Table 8. Numbers of the principal plankton species in the Norwegian Sea in the surface layer (0—50 m.) in waters of different origin (June—July 1956)

| Composition of plankton         | Atlantic water on the continental shelf<br>Station 837<br>15. June |     | Atlantic water in the open Norwegian Sea<br>Station 848<br>17. June |     | Mixed water near the East Greenland Current<br>Station 964<br>15. July |      | Mixed water at Jan Mayen<br>Station 960<br>17. July |      | Polar water<br>Station 322<br>22. June 1955 |      |
|---------------------------------|--------------------------------------------------------------------|-----|---------------------------------------------------------------------|-----|------------------------------------------------------------------------|------|-----------------------------------------------------|------|---------------------------------------------|------|
|                                 | Number                                                             | %   | Number                                                              | %   | Number                                                                 | %    | Number                                              | %    | Number                                      | %    |
|                                 |                                                                    |     |                                                                     |     |                                                                        |      |                                                     |      |                                             |      |
| Nauplii Calanoida               | —                                                                  | —   | —                                                                   | —   | 48                                                                     | 1.93 | 43                                                  | 2.6  | —                                           | —    |
| <i>Calanus finmarchicus</i> ... | 2415                                                               | 87  | 50                                                                  | 81  | 345                                                                    | 13.8 | 47                                                  | 2.8  | 326                                         | 5.2  |
| <i>Calanus hyperboreus</i> .... | 25                                                                 | 0.8 | 3                                                                   | 4.7 | 87                                                                     | 3.5  | 84                                                  | 5.1  | 3916                                        | 63.5 |
| <i>Pseudocalanus</i> sp. .      | 220                                                                | 7.8 | 1                                                                   | 1.6 | 380                                                                    | 15.3 | 324                                                 | 19.2 | 46                                          | 0.7  |
| <i>Oithona similis</i> ...      | 15                                                                 | 0.4 | 1                                                                   | 1.6 | 1454                                                                   | 58.0 | 1171                                                | 69   | 1910                                        | 30.3 |
| <i>Oithona atlantica</i> ..     | —                                                                  | —   | 1                                                                   | 1.6 | 70                                                                     | 2.83 | 11                                                  | 0.7  | —                                           | —    |
| <i>Oithona borealis</i> ...     | —                                                                  | —   | —                                                                   | —   | 77                                                                     | 3.2  | 3                                                   | 0.18 | —                                           | —    |
| <i>Metridia lucens</i> ...      | —                                                                  | —   | 2                                                                   | 3.2 | —                                                                      | —    | —                                                   | —    | —                                           | —    |
| <i>Metridia longa</i> ....      | —                                                                  | —   | —                                                                   | —   | —                                                                      | —    | 2                                                   | 0.12 | —                                           | —    |
| Euphausiacea juv. .             | 28                                                                 | 1.1 | 1                                                                   | 1.6 | —                                                                      | —    | —                                                   | —    | —                                           | —    |
| Hyperidae .....                 | 10                                                                 | 0.3 | 3                                                                   | 4.7 | 33                                                                     | 1.32 | 4                                                   | 0.24 | 20                                          | 0.3  |
| Ostracoda .....                 | —                                                                  | —   | —                                                                   | —   | 1                                                                      | 0.04 | —                                                   | —    | —                                           | —    |
| Gastropoda juv. .               | 60                                                                 | 2.0 | —                                                                   | —   | 2                                                                      | 0.08 | —                                                   | —    | —                                           | —    |
| Chaetognatha ....               | —                                                                  | —   | —                                                                   | —   | —                                                                      | —    | 1                                                   | 0.06 | —                                           | —    |
| Total .....                     | 2793                                                               | 100 | 62                                                                  | 100 | 2497                                                                   | 100  | 1690                                                | 100  | 6218                                        | 100  |

Surveys of separate areas of the Norwegian Sea were conducted in 1956, when the biological spring (as exemplified by the mass spawning of *Calanus finmarchicus* and the appearance of *Phaeocystis*) on the north-west coast of Norway was found to have started in the first week of April, i. e., at the same time as in 1948.

Further surveys were conducted in June—July 1956 in the area between Lofoten and Jan Mayen, in the northern part of the Norwegian Sea. A detailed survey of the polar front was made in the locality of the Mona sill.

It was again confirmed that the plankton composition undergoes considerable change as one moves westward towards regions of mixed and polar waters.

The plankton near the Atlantic continental shelf consists mainly of *Calanus finmarchicus* (up to 87%). *Oithona similis* and *Pseudocalanus gracilis* (*Pseudocalanus minutus* according to WIBORG) prevail in mixed waters, *Calanus hyperboreus* (63%) in polar waters (see Table 8).

In April—May *Calanus finmarchicus* makes up the greater part of the biomass (about 2000 mg./m.<sup>3</sup>) in the east, but in the north-western part of the Norwegian Sea, the numbers of *Calanus hyperboreus* were multiplying rapidly at that time and we met even more (about 4000 mg./m.<sup>3</sup>) of that species in the upper water layers.

The percentage of *Calanus finmarchicus* in the plankton decreases westward of the continental

shelf, where low temperatures hinder its development.

Stages IV—V of *Calanus finmarchicus* prevail in Atlantic waters of 7.3° temperature; in the cold water near the East Greenland Current 47.7% of the plankton consists of calanoid nauplii and 27.7% of stage IV *Calanus finmarchicus*.

It was found that in the Jan Mayen area the development of plankton starts 2½—3 months later than at Lofoten.

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#### Scottish Plankton Investigations in 1956

Scottish research ships sampled the plankton between the Butt of Lewis and Faroe Bank in July, August, and November, and between Faroe and Shetland in September and November. The area of the Outer Banks from west of Rockall to north of Lousy and Faroe Banks was worked in July, the Faroe-Iceland Ridge in August, and to the north of Iceland in September.

#### Phytoplankton

The dominant diatoms in the Faroe area in July and August were *Nitzschia delicatissima*, *Thalassiosira gravida*, *Thalassiothrix nitzschoides*, and *Chaetoceros* spp., as opposed to the Scottish side of the Faroe Channel where *Rhizosolenia alata* f. *gracillima* was dominant. In November *Chaetoceros decipiens* and *Thalassiothrix nitzschoides* were still

the most common species, with *Ceratium fusus* in the Faroe area, and this community extended to the edge of the Near Northern Seas area where *Rhizosolenia shrubsolei*, *Chaetoceros atlanticus* and *Ceratium furca* predominated.

To the north-west of Iceland phytoplankton was very dense in September, the dominant species being *Thalassiothrix longissima*, *Rhizosolenia alata* f. *gracillima*, *Chaetoceros decipiens*, *C. convolutus*, and *C. concavicornis*.

#### Zooplankton

The oceanic species west and north-west of the continental shelf were of two communities—open Atlantic species and Lusitanian species. The Atlantic forms, typified by *Salpa fusiformis*, *Doliolletta gegenbauri* f. *tritonis*, *Clio pyramidata*, *Arachnactes*, *Sulculeolaria biloba*, *Agalma*, and *Lensia conoidea*, etc., were in July most abundant west of 10°W., and to the north-west of Rosemary Knoll. The Lusitanian species, typified by the siphonophores *Rosacea plicata*, *Nectopyramis thetis*, *Bassia bassensis*, *Vogtia* (3 spp.), and *Lensia*

*fowleri*, were found mostly east of Rockall and between Rosemary Knoll and the Hebrides. This Lusitanian fauna remained as a tongue lying across the Wyville Thomson Ridge below about 250 m. from August to November, but it did not reach as far as the Faroe-Flugga line of stations. The Atlantic species continued through the Faroe-Shetland Channel into the Norwegian Sea and also extended along the Faroe-Iceland Ridge, carrying *Salpa fusiformis*, *Agalma*, and *Sulculeolaria* to the south-east coast of Iceland. There was also evidence of a penetration of the same Atlantic community to the west of Iceland to 66°10'N., 27°00'W. but there is no information from Scottish vessels to link these two.

Crustaceous plankton was, as usual, rather sparse in the open oceanic water, but *Calanus*, *Acartia*, *Oithona*, etc., formed a rich crustacean community to the north-east of Iceland and also west of Iceland between the coast and the oceanic water and south of the rich phytoplankton patch.

J. H. FRASER

## THE FISH

### Redfish

#### German Market Investigations on Redfish in 1956

#### Length Composition of the Landings — Sex Ratio

(Figures 55–65; Table 9)

In 1956 landings from 142 trawlers were dealt with on Bremerhaven fish market; 37,208 measurements were made and 8,520 otoliths taken. In most cases males and females were distinguished. Samples from all fishing grounds were taken every month in which fishing took place. In general about 200 fish were measured from each landing; this seemed to be sufficient to give a good idea of the length composition of the total catch. In mixed catches it was not always possible to distinguish with certainty between “*marinus*” and “*mentella*” types, and accordingly no attempt was made to separate the records for the two types.

Unfortunately the age determinations, being very troublesome, have not been completed, so that only the length composition of the landings and the proportions of the sexes can be dealt with here. The age determinations will be published as soon as possible, for they alone enable us to understand the various changes in length distribution.

As length composition often varies remarkably within a few days samples were not in general grouped by month. In some cases only (e.g., Dohrn Bank) was it possible to take the mean of the samples in a month, when differences were not unusually large.

The collection of 126 samples, dealt with here, provided a total of 33,764 measurements. The samples were divided between fishing grounds, as shown in Table 9. Other details are shown by the diagrams.

(a) *Greenland, W. coast* (Table 9(a) and Fig. 55)

For West Greenland waters we have 8 samples taken between May and August. In May the fish were relatively small (36 to 46 cm., mean 41.3 cm.); there were no fish over 52 cm. Two weeks later the range was much wider and length reached up to nearly 70 cm. Large fish were nearly as numerous as small and the mean length rose to 47.5 cm. In June and early July the fish became smaller and smaller, until the mean length was only 39.1 cm. In the second catch in July a number of larger fish appeared which caused the average length to rise again to 43.8 cm., but in August fewer large fish were taken, so that the mean length declined to 39.4 cm. The sex ratio did not change noticeably during the 4 months. In every case the males were smaller than the females (0.5 to 2.7 cm.).

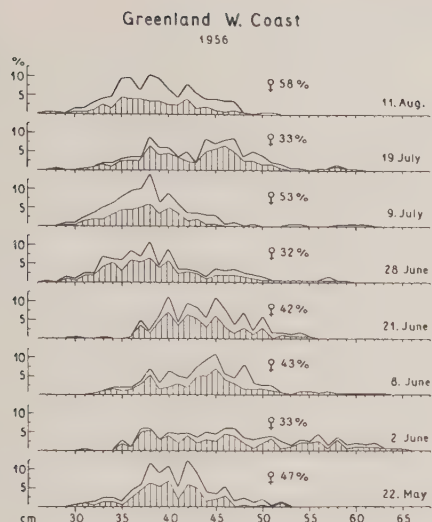


Figure 55. Length composition of redfish landings from West Greenland. Non-smoothed %-curves. Striated ♀♀, white ♂♂.

(b) **Greenland, E. coast (Angmagssalik)** (Table 9(b) and Fig. 56)

For this area 14 samples were obtained between March and November. We see that in general the redfish on the east coast of Greenland are larger than those on the west (mean length between 43.4 and 48.9 cm.). The length composition of the landings in March did not change essentially. Females of all length groups were present in approximately the same proportions. A group of larger females ranging from 45 to 54 cm. appeared in mid-April (13. IV.) but they did not occur in the catch on 18. April and only the smaller fish remain in considerable numbers. We must assume that the larger females migrated to the open ocean for spawning, whilst the smaller fish were not then ripe and would follow later or were still immature. A second group of females, somewhat smaller than those sampled in mid-April were found in the sample of 27. April, but were absent from the May landing. It is likely that these fish also moved into open water for spawning. As the numbers of males remained steady during this period, we must assume that they do not take part in the spawning migrations, at least not on a large scale. The smaller of the females remaining in May and June were probably still immature, while the larger fish would not spawn that year. No samples are available for July. At the end of August the larger females were again present in considerable numbers; probably these fish had returned from spawning. In August and still more so in September a wave

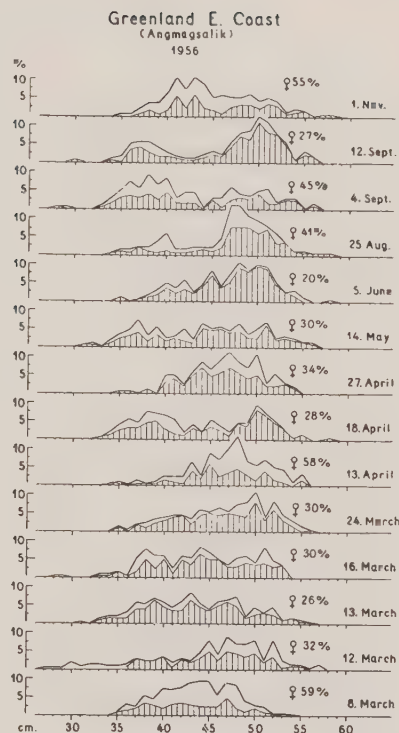


Figure 56. Length composition of redfish landings from East Greenland (Angmagssalik). For explanation, see Figure 55.

of small fish (35—40 cm.) entered the stock. In November the smallest and the largest fish disappear and a group 40—45 cm. in length predominates.

(c) **Greenland, E. coast (Dohrn Bank)** (Table 9(c) and Fig. 57)

Twenty-one landings from this area made between January and December were investigated. In this case monthly mean values are used for our curves; in the table the figures for each sample are recorded separately.

In general, the mean length of the Dohrn Bank redfish much resembles that of Angmagssalik fish. It is remarkable that from January to April almost no females were present. From this we must conclude that maturing females do not congregate in this region before spawning; they may perhaps travel after fertilization to the Angmagssalik district or to other grounds.

The proportion of females increased slowly from May onwards, reaching its highest value (60%) in October, and then dropping to 22% in December. It seems that the spent females return to Dohrn Bank from May onwards and that after fertilization (according to MAGNUSSEN fertilization takes place in the late autumn) they move elsewhere.



Table 9. Sex ratio (%) and mean length of the sexes in the single samples

| Date<br>1956                                        | Sex ratio, % |      | Mean length, cm. |      |      | Total<br>number<br>invest. | Date<br>1956                                                                  | Sex ratio, %        |      | Mean length, cm. |      |      | Total<br>number<br>invest. |
|-----------------------------------------------------|--------------|------|------------------|------|------|----------------------------|-------------------------------------------------------------------------------|---------------------|------|------------------|------|------|----------------------------|
|                                                     | ♂            | ♀    | ♂                | ♀    | ♂+♀  |                            |                                                                               | ♂                   | ♀    | ♂                | ♀    | ♂+♀  |                            |
| (a) Greenland — W. coast, 8 samples                 |              |      |                  |      |      |                            | (d) Iceland — N.W. coast, 20 samples                                          |                     |      |                  |      |      |                            |
| 22. V.                                              | 52.6         | 47.4 | 40.7             | 42.0 | 41.3 | 312                        | 23. I.                                                                        | 87.2                | 12.8 | 46.3             | 42.8 | 45.8 | 179                        |
| 2. VI.                                              | 67.2         | 32.8 | 46.6             | 49.3 | 47.5 | 305                        | 27. I.                                                                        | sexes not separated |      |                  |      | 40.7 | 206                        |
| 8. VI.                                              | 56.9         | 43.1 | 44.4             | 44.9 | 44.6 | 320                        | 12. VI.                                                                       | 62.3                | 37.7 | 40.9             | 41.8 | 41.2 | 353                        |
| 21. VI.                                             | 57.7         | 42.3 | 44.4             | 46.0 | 45.1 | 326                        | 11. VII.                                                                      | 57.8                | 42.2 | 40.4             | 40.2 | 40.3 | 330                        |
| 28. VI.                                             | 67.8         | 32.2 | 39.8             | 40.7 | 40.1 | 351                        | 7. VIII.                                                                      | 50.3                | 49.7 | 48.8             | 47.6 | 48.2 | 304                        |
| 9. VII.                                             | 46.7         | 53.3 | 38.7             | 39.4 | 39.1 | 383                        | 22. VIII.                                                                     | 53.7                | 46.3 | 43.2             | 44.4 | 43.7 | 330                        |
| 19. VII.                                            | 67.1         | 32.9 | 43.4             | 44.6 | 43.8 | 337                        | 27. VIII.                                                                     | 57.2                | 42.8 | 42.3             | 42.9 | 42.6 | 222                        |
| 11. VIII.                                           | 41.7         | 58.3 | 39.0             | 39.8 | 39.4 | 204                        | 31. VIII.                                                                     | 50.6                | 49.4 | 43.0             | 42.8 | 42.9 | 279                        |
|                                                     |              |      |                  |      |      | 2,538                      | 3. IX.                                                                        | 33.7                | 66.3 | 41.3             | 42.7 | 42.2 | 289                        |
| (b) Greenland — E. coast (Angmagssalik), 14 samples |              |      |                  |      |      |                            | 6. IX.                                                                        | 62.9                | 37.1 | 40.7             | 42.5 | 41.4 | 317                        |
| 8. III.                                             | 41.3         | 58.7 | 43.6             | 44.7 | 44.2 | 317                        | 22. IX.                                                                       | 60.2                | 39.8 | 37.7             | 39.9 | 38.6 | 176                        |
| 12. III.                                            | 55.6         | 44.4 | 46.3             | 49.1 | 47.4 | 498                        | 8. X.                                                                         | 62.1                | 37.9 | 43.3             | 42.3 | 42.9 | 190                        |
| 13. III.                                            | 74.1         | 25.9 | 44.2             | 43.8 | 44.1 | 348                        | 15. X.                                                                        | 80.9                | 19.1 | 41.7             | 44.7 | 42.3 | 194                        |
| 16. III.                                            | 69.8         | 30.2 | 45.1             | 43.8 | 44.7 | 300                        | 18. X.                                                                        | 71.6                | 28.4 | 40.7             | 41.2 | 40.8 | 317                        |
| 24. III.                                            | 70.3         | 29.7 | 47.0             | 48.2 | 47.3 | 322                        | 22. X.                                                                        | 73.9                | 26.1 | 40.7             | 41.6 | 40.9 | 203                        |
| 13. IV.                                             | 42.2         | 57.8 | 48.0             | 49.5 | 48.9 | 307                        | 29. X.                                                                        | 51.2                | 48.8 | 43.2             | 44.3 | 43.7 | 211                        |
| 18. IV.                                             | 72.1         | 27.9 | 45.8             | 41.8 | 44.7 | 300                        | 5. XI.                                                                        | 51.6                | 48.4 | 42.3             | 42.5 | 42.4 | 188                        |
| 27. IV.                                             | 65.8         | 34.2 | 47.7             | 48.2 | 47.9 | 311                        | 7. XI.                                                                        | 61.7                | 38.3 | 44.9             | 46.0 | 45.3 | 206                        |
| 14. V.                                              | 69.5         | 30.5 | 46.0             | 43.2 | 45.1 | 298                        | 7. XI.                                                                        | 46.2                | 53.8 | 42.3             | 45.5 | 44.0 | 208                        |
| 5. VI.                                              | 79.7         | 20.3 | 47.9             | 46.6 | 47.6 | 308                        | 8. XII.                                                                       | 41.9                | 58.1 | 39.1             | 39.9 | 39.5 | 227                        |
| 25. VIII.                                           | 59.0         | 41.0 | 48.5             | 46.2 | 47.5 | 297                        |                                                                               |                     |      |                  |      |      | 4,929                      |
| 4. IX.                                              | 54.8         | 45.2 | 44.6             | 42.0 | 43.4 | 318                        | (e) Iceland — S.W. coast, 10 samples                                          |                     |      |                  |      |      |                            |
| 12. IX.                                             | 73.2         | 26.8 | 48.1             | 43.9 | 47.6 | 307                        | 3. IV.                                                                        | 27.2                | 72.8 | 41.8             | 43.9 | 43.3 | 202                        |
| 1. XI.                                              | 45.3         | 54.7 | 47.2             | 44.5 | 45.8 | 296                        | 4. IV.                                                                        | 20.4                | 79.6 | 41.5             | 45.7 | 44.8 | 302                        |
|                                                     |              |      |                  |      |      | 4,527                      | 19. IV.                                                                       | 10.8                | 89.2 | 43.7             | 45.1 | 45.0 | 204                        |
| (c) Greenland — E. coast (Dohrn Bank), 21 samples   |              |      |                  |      |      |                            | 26. IV.                                                                       | 28.9                | 71.1 | 41.8             | 43.6 | 43.1 | 211                        |
| 2. I.                                               | 76.8         | 23.2 | 45.7             | 43.8 | 45.3 | 190                        | 5. V.                                                                         | 7.7                 | 92.3 | 43.4             | 43.9 | 43.9 | 222                        |
| 2. I.                                               | 84.6         | 15.4 | 45.8             | 42.5 | 45.3 | 182                        | 18. IX.                                                                       | 70.4                | 29.6 | 45.6             | 46.8 | 46.0 | 285                        |
| 3. I.                                               | 71.9         | 28.1 | 46.6             | 42.2 | 45.3 | 185                        | 25. X.                                                                        | 53.7                | 46.3 | 45.4             | 46.8 | 46.1 | 188                        |
| 6. I.                                               | 68.0         | 32.0 | 48.3             | 45.2 | 47.3 | 319                        | 6. XI.                                                                        | 47.9                | 52.1 | 50.9             | 51.7 | 51.3 | 192                        |
| 9. II.                                              | 86.0         | 14.0 | 46.5             | 42.3 | 45.9 | 326                        | 12. XI.                                                                       | 31.8                | 68.2 | 43.9             | 46.3 | 45.5 | 301                        |
| 10. IV.                                             | 92.7         | 7.3  | 44.8             | 40.6 | 44.5 | 309                        | 28. XI.                                                                       | 54.0                | 46.0 | 49.2             | 51.0 | 50.1 | 213                        |
| 30. IV.                                             | 98.9         | 1.1  | 44.1             | 48.4 | 44.1 | 338                        |                                                                               |                     |      |                  |      |      | 2,320                      |
| 8. V.                                               | 81.4         | 18.6 | 42.8             | 39.1 | 42.1 | 335                        | (f) Iceland — S. coast, 2 samples                                             |                     |      |                  |      |      |                            |
| 12. V.                                              | 87.3         | 12.7 | 44.3             | 45.5 | 44.5 | 314                        | 19. IX.                                                                       | 64.1                | 35.9 | 44.7             | 47.5 | 45.7 | 181                        |
| 23. V.                                              | 73.8         | 26.2 | 46.5             | 42.6 | 45.5 | 321                        | 24. IX.                                                                       | 60.7                | 39.3 | 40.2             | 43.3 | 41.4 | 196                        |
| 14. VI.                                             | 81.3         | 18.7 | 44.6             | 43.2 | 44.3 | 314                        |                                                                               |                     |      |                  |      |      | 377                        |
| 18. VI.                                             | 70.2         | 29.8 | 46.8             | 45.7 | 46.4 | 290                        | (g) Iceland — Faroe Ridge ("Rosengarten" and E. of<br>the Faroes), 12 samples |                     |      |                  |      |      |                            |
| 20. VI.                                             | 54.6         | 45.4 | 45.5             | 46.1 | 45.8 | 295                        | 1. VI.                                                                        | 57.8                | 42.2 | 44.6             | 46.9 | 45.5 | 211                        |
| 5. VII.                                             | 60.1         | 39.9 | 45.6             | 43.4 | 44.8 | 300                        | 7. VI.                                                                        | 37.8                | 62.2 | 44.1             | 46.6 | 45.7 | 201                        |
| 15. VIII.                                           | 62.9         | 37.1 | 45.3             | 41.2 | 43.8 | 313                        | 22. VI.                                                                       | 40.0                | 60.0 | 44.3             | 46.5 | 45.6 | 205                        |
| 5. IX.                                              | 64.6         | 35.4 | 44.4             | 43.7 | 44.2 | 396                        | 8. IX.                                                                        | 59.8                | 40.2 | 44.6             | 47.3 | 45.7 | 194                        |
| 13. IX.                                             | 60.0         | 40.0 | 42.0             | 44.0 | 42.8 | 326                        | 11. IX.                                                                       | 50.2                | 49.8 | 44.3             | 47.1 | 45.7 | 201                        |
| 26. IX.                                             | 72.3         | 27.7 | 45.4             | 44.3 | 45.1 | 311                        | 2. XI.                                                                        | 47.8                | 52.2 | 44.4             | 46.0 | 45.2 | 186                        |
| 9. X.                                               | 40.0         | 60.0 | 42.4             | 45.6 | 44.3 | 306                        | 5. XI.                                                                        | 37.1                | 62.9 | 44.2             | 47.1 | 46.0 | 197                        |
| 5. XII.                                             | 82.5         | 17.5 | 44.2             | 43.0 | 44.0 | 293                        | 12. XI.                                                                       | 28.5                | 71.5 | 45.2             | 47.6 | 46.9 | 214                        |
| 7. XII.                                             | 73.3         | 26.7 | 48.1             | 45.1 | 47.3 | 419                        | 19. XI.                                                                       | 57.5                | 42.5 | 44.9             | 47.7 | 46.1 | 200                        |
|                                                     |              |      |                  |      |      | 6,382                      | 3. XII.                                                                       | 36.6                | 63.4 | 45.3             | 48.0 | 47.0 | 186                        |
|                                                     |              |      |                  |      |      |                            | 8. XII.                                                                       | 54.6                | 45.4 | 46.7             | 50.7 | 48.5 | 191                        |
|                                                     |              |      |                  |      |      |                            | 20. XII.                                                                      | 56.9                | 43.1 | 45.1             | 47.8 | 46.3 | 190                        |
|                                                     |              |      |                  |      |      |                            |                                                                               |                     |      |                  |      |      | 2,376                      |

In this locality also, the males remained on the bank during the spawning period. This supports the view that they do not take part in the spawning migration.

(d) Iceland, north-west coast (Table 9(d) and Fig. 58)

For this area 20 samples were measured, from

catches on the "Gammelloch", Barda, Vikural, and Snæfellsjökul grounds. The material is therefore somewhat heterogeneous. Five catches in October from the Snæfellsjökul area have been taken together. There were no samples for late winter and spring. The January sample much resembles

Table 9 (continued)

| Date<br>1956                                   | Sex ratio, ‰        |      | Mean length, cm. |      |      | Total<br>number<br>invest. |
|------------------------------------------------|---------------------|------|------------------|------|------|----------------------------|
|                                                | ♂                   | ♀    | ♂                | ♀    | ♂+♀  |                            |
| (h) Bear Island, 13 samples                    |                     |      |                  |      |      |                            |
| 12. IV.                                        | 70.4                | 29.6 | 37.3             | 35.9 | 36.8 | 223                        |
| 17. IV.                                        | 84.8                | 15.2 | 38.1             | 40.4 | 38.4 | 197                        |
| 20. VII.                                       | 61.1                | 38.9 | 36.0             | 39.9 | 37.5 | 239                        |
| 25. VII.                                       | 21.8                | 78.2 | 39.6             | 40.3 | 40.1 | 197                        |
| 27. VII.                                       | 19.5                | 80.5 | 39.5             | 41.5 | 41.1 | 190                        |
| 8. VIII.                                       | 21.2                | 78.8 | 39.7             | 41.4 | 41.0 | 193                        |
| 9. VIII.                                       | 23.4                | 76.6 | 38.4             | 41.4 | 40.7 | 192                        |
| 16. VIII.                                      | 31.8                | 68.2 | 38.1             | 39.4 | 38.9 | 214                        |
| 24. VIII.                                      | 33.7                | 66.3 | 38.4             | 40.2 | 39.6 | 199                        |
| 28. VIII.                                      | 41.0                | 59.0 | 39.1             | 41.3 | 40.4 | 179                        |
| 7. IX.                                         | 41.0                | 59.0 | 38.8             | 41.1 | 40.1 | 200                        |
| 25. IX.                                        | 54.4                | 45.6 | 38.0             | 40.5 | 39.1 | 206                        |
| 19. XI.                                        | 38.5                | 61.5 | 40.2             | 41.5 | 41.0 | 231                        |
|                                                |                     |      |                  |      |      | 2,660                      |
| (i) Spitsbergen, 2 samples                     |                     |      |                  |      |      |                            |
| 20. VI.                                        | 58.3                | 41.7 | 42.6             | 41.9 | 42.3 | 192                        |
| 22. VI.                                        | 54.0                | 46.0 | 39.5             | 41.3 | 40.3 | 231                        |
|                                                |                     |      |                  |      |      | 423                        |
| (j) Western Barents Sea, 4 samples             |                     |      |                  |      |      |                            |
| 2. V.                                          | 74.3                | 25.7 | 44.0             | 40.7 | 43.2 | 226                        |
| 24. V.                                         | 66.8                | 33.2 | 50.4             | 44.0 | 48.3 | 199                        |
| 26. V.                                         | 85.4                | 14.6 | 48.3             | 42.8 | 47.4 | 202                        |
| 20. XII.                                       | 73.7                | 26.3 | 51.9             | 48.5 | 51.0 | 175                        |
|                                                |                     |      |                  |      |      | 802                        |
| (k) Norwegian coast (Lofoten area), 21 samples |                     |      |                  |      |      |                            |
| 18. I.                                         | sexes not separated |      |                  |      | 38.6 | 194                        |
| 21. I.                                         | sexes not separated |      |                  |      | 40.3 | 223                        |
| 1. II.                                         | sexes not separated |      |                  |      | 39.4 | 247                        |
| 8. II.                                         | sexes not separated |      |                  |      | 36.3 | 220                        |
| 3. III.                                        | sexes not separated |      |                  |      | 40.1 | 232                        |
| 10. III.                                       | 38.2                | 61.8 | 35.9             | 38.2 | 37.3 | 444                        |
| 19. III.                                       | 39.3                | 60.7 | 38.2             | 40.3 | 39.5 | 346                        |
| 23. III.                                       | 38.7                | 61.3 | 40.0             | 46.8 | 44.4 | 546                        |
| 5. IV.                                         | 33.5                | 66.5 | 37.9             | 42.9 | 41.2 | 529                        |
| 11. IV.                                        | 19.6                | 80.4 | 39.7             | 44.4 | 43.5 | 318                        |
| 16. IV.                                        | 18.6                | 81.4 | 40.0             | 44.2 | 43.4 | 356                        |
| 24. IV.                                        | 27.3                | 72.7 | 43.1             | 47.4 | 46.2 | 297                        |
| 9. V.                                          | 57.5                | 42.5 | 38.7             | 45.5 | 41.6 | 193                        |
| 29. VI.                                        | 20.6                | 79.4 | 40.6             | 41.6 | 41.4 | 304                        |
| 3. VII.                                        | 39.5                | 60.5 | 38.2             | 40.6 | 39.7 | 327                        |
| 20. IX.                                        | 57.8                | 42.2 | 44.1             | 43.9 | 44.0 | 373                        |
| 1. X.                                          | 62.9                | 37.1 | 34.0             | 34.4 | 34.1 | 188                        |
| 3. X.                                          | 39.3                | 60.7 | 43.3             | 43.4 | 43.3 | 183                        |
| 12. X.                                         | 60.7                | 39.3 | 37.2             | 38.5 | 37.7 | 296                        |
| 17. X.                                         | 50.6                | 49.4 | 37.2             | 40.4 | 38.8 | 326                        |
| 24. X.                                         | 53.6                | 46.4 | 38.2             | 38.7 | 38.4 | 288                        |
|                                                |                     |      |                  |      |      | 6,430                      |

that of the same month from the Dohrn Bank in respect of the sex ratio, the males predominated to the extent of 87%. In June females of all sizes were present, those of the 35—40 cm. group being most numerous. In August medium-size fish predominated, but the mean length decreased slowly towards the end of September (38.6 cm.). The medium-size fish reappear, and after 7. November a group of larger fish, 45—50 cm., was present so that the mean length rose to 45.3 cm. In the last catch of the year only small fish (mean

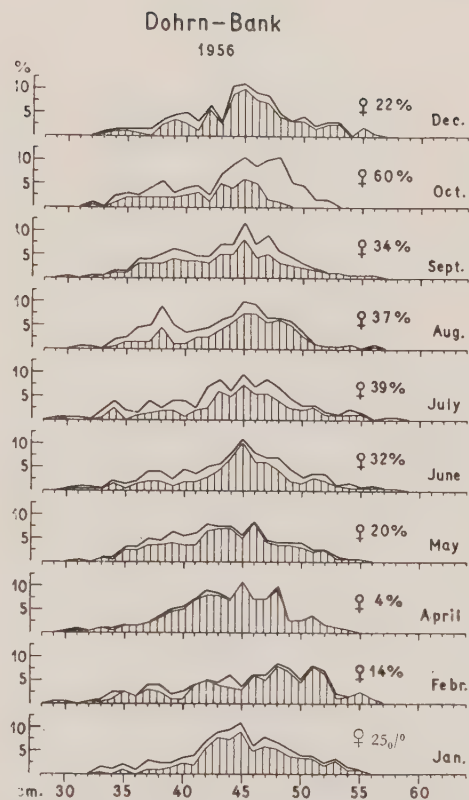


Figure 57. Length composition of redfish landings from East Greenland (Dohrn Bank). For explanation, see Figure 55.

length 39.5 cm.) were present. In the November and December catches there were rather more females than males. As the females in the June and July landings were chiefly small fish, 35—40 cm. long, which had probably not then spawned, we must conclude that the large spent females return to these grounds in early August, since they become proportionately more numerous.

(e) Iceland, south-west coast (Table 9(e) and Fig. 59)

Ten samples collected between April and November were examined. The south-west coast of Iceland seems to be the main place in which mature females assemble in spring before migrating into the open ocean for spawning. Throughout the month of April and up to 5. May females were by far the most numerous in the landings. As the "Anton Dohrn" catches in April 1957 indicate these fish are with few exceptions mature (Std. VI b—c; the embryos are well developed, mostly with iridescent eyes).

The developments occurring in the subsequent months are not known as no samples were taken. We must assume, however, that shortly after 5. May

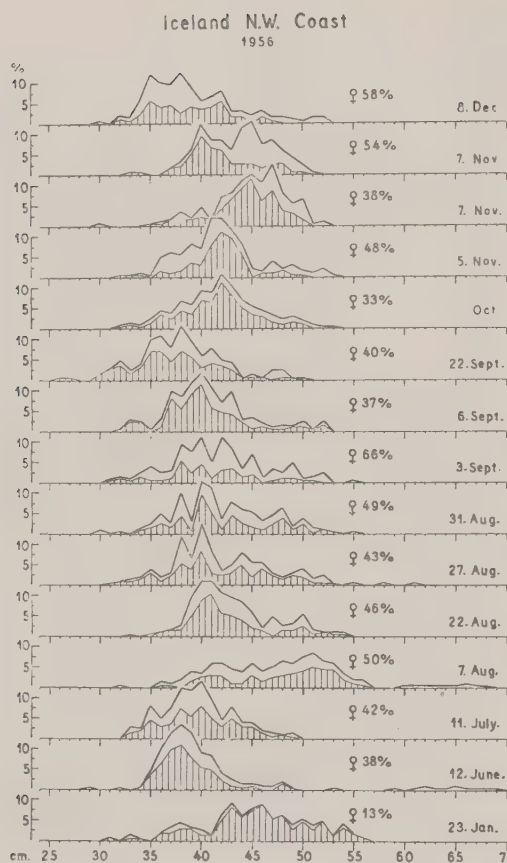


Figure 58. Length composition of redfish landings from N.W. Iceland. For explanation, see Figure 55.

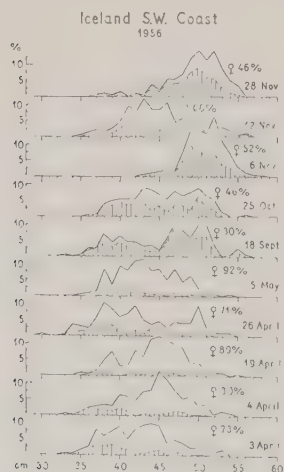


Figure 59. Length composition of redfish landings from S.W. Iceland. For explanation, see Figure 55.



Figure 60. Length composition of redfish landings from S. Iceland. For explanation, see Figure 55.

the fish left the region for spawning, since the fishery suddenly became unprofitable, and no considerable catches were made until September. As may be seen in Figure 59, the larger females appear again in September and the proportion of females increases in October and November to 68%. That is the season of fertilization. Afterwards the females decrease in number, and probably a separation of the sexes takes place to some extent.

(f) Iceland, south coast (Table 9(f) and Fig. 60)

Only two samples were obtained in September. Though both catches came from the same fishing ground and were landed within 5 days of each other, the length compositions differ remarkably from each other, the average length in the first landing being 45.7 cm., and in the second only 41.4 cm.

(g) Iceland-Faroe Ridge ("Rosengarten" and deeper Faroe waters) (Table 9 (g) and Fig. 61)

For this area 12 landings were examined; the first three came from "Rosengarten" in April, and the remaining nine for the period September to December, were from deeper waters north and north-east of the Faroe Islands. In all cases the fish landed were exclusively of the "mentella" type.

The landings from "Rosengarten" in April showed an assemblage of females. It is to be assumed that these fish left the area in early May for spawning. We have indeed no samples to support this, but we know from experience that in the "Rosengarten" area redfish fishing is not profitable in May and the first half of June; this means that at that time the fish are not present in numbers. The general fishing begins at the end of June and beginning of July, when the fish return from spawning. In both 1955 and 1956 the summer and autumn fishing in the Rosengarten was very poor. Hydrographic investigations with the "Anton Dohrn" showed that very cold water masses flowed over the Iceland-Faroe Ridge from the Norwegian Sea, so that in both 1955 and 1956 the conditions for redfish were not favourable. Probably



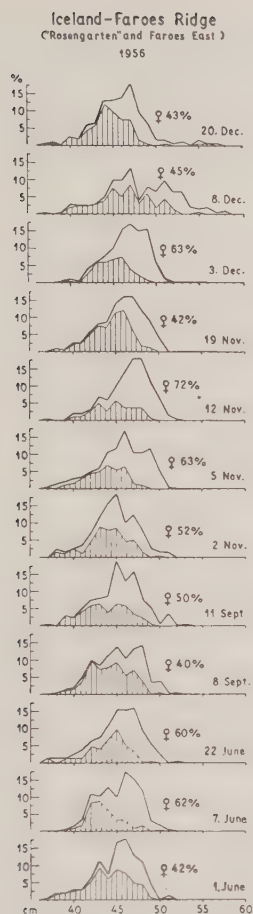


Figure 61. Length composition of redfish landings from the Iceland-Faroe Ridge and Faroese waters. For explanation, see Figure 55.

they withdrew to deeper water near the Faroes, for good catches were made there. The fish caught in autumn in Faroe waters have the same length composition as the spring-caught fish on the Rosengarten. The increase of about 2 cm. in the average length may be due to natural growth during the intervening 4 months. In general the females are somewhat more numerous than the males in the autumn landings, but in December they fall to 43%. The males are usually about 2 cm. shorter than the females.

(h) Bear Island (Table 9(h) and Fig. 62)

For the Bear Island region 13 samples collected in April and from June to November were examined. All fish were of the "mentella" type. The redfish in this area were much smaller than those in the Rosengarten and Faroe area, the mean length ranging from 36 to 40 cm. The deep-sea redfish

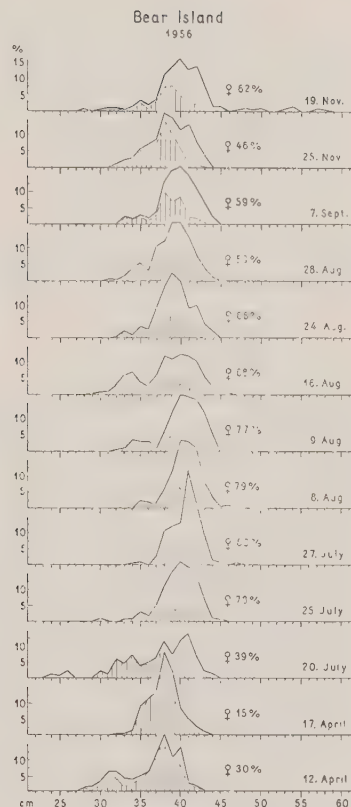


Figure 62. Length composition of redfish landings from Bear Island. For explanation, see Figure 55.

of the Bear Island region are not young stages of the deep-sea redfish on the Iceland-Faroe Ridge, for the two groups differ in several respects (e.g., in the mean number of vertebrae, and in otolith size).

In April the proportion of females was very low. It seems that the mature fish had either already left the area or would assemble there later. Unfortunately no May and June catches are available to follow the development of events. In July females, from 37 to 44 cm. in length, by far outweighed males. In summer and early autumn the

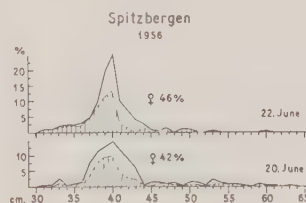


Figure 63. Length composition of redfish landings from Spitsbergen. For explanation, see Figure 55.

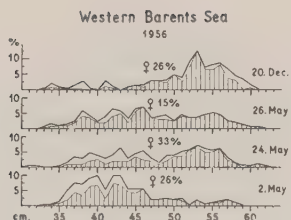


Figure 64. Length composition of redfish landings from the western Barents Sea. For explanation, see Figure 55.

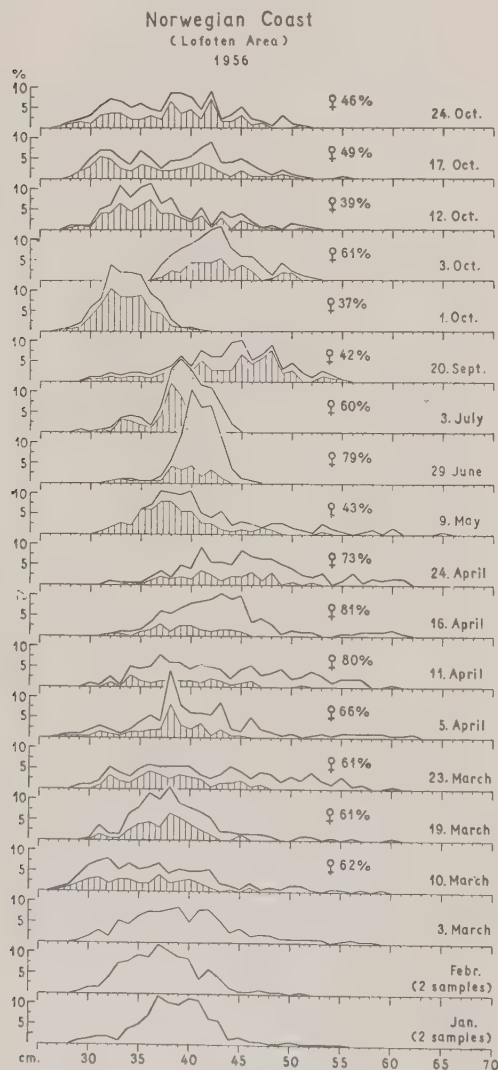


Figure 65. Length composition of redfish landings from the Norwegian coast (Lofoten). For explanation, see Figure 55.

proportion of females fell slowly, reaching 46% at the end of September, but in November females at 62%, again predominated. The fact that males are present in April in this region also provides further support for the supposition that the males take no part in the spawning migration.

(i) Spitsbergen (Table 9(i) and Fig. 63)

Only two catches landed at the end of June were examined. All fish were of the "*marinus*" type, though the length composition much resembled that of the Bear Island deep-sea redfish. The catches show no essential differences in respect of length distribution and sex ratio.

(j) Western Barents Sea (Table 9(j) and Fig. 64)

Three landings in May and one in December were examined. In May the proportion of females in the catches was only 15 to 33%; they were mostly small fish. It seems that at that time the spent females had not returned from spawning.

In the December landing females amounted to only 26%, being either small or large fish; medium-size females were almost entirely absent. As no catches for June to November are available, later developments are unknown.

(k) Norwegian coast, Lofoten area (Table 9(k) and Fig. 65)

For this area (comprising the grounds between Røst and Malangen) 21 landings were examined. In 5 samples, for January to March, sex was not distinguished.

In March, April, and May the situation much resembles that on the south-west coast of Iceland, differing only in that the males were relatively more numerous and were shorter (mean length 39—44 cm.). The larger fish were nearly all females. In spring the mature females assemble in this area and move away during April and the first half of May. Afterwards, no fish remain except a few males and some immature females, so that fishing is not profitable until the spent females return in June. Females are by far the most numerous in the catches in June and July, but afterwards the proportion declines, reaching 37% in October. Then it rises again, so that in the last landings examined both sexes were found in nearly equal numbers.

ADOLF KOTTHAUS

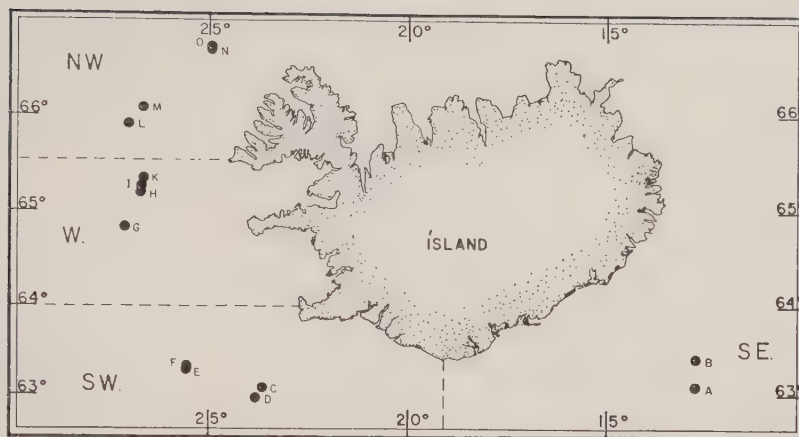


Figure 66. Chart showing the positions of sampling.

### Notes on the Length Distribution of Redfish (*Sebastes marinus* L.) in Icelandic Waters in 1956

(Figures 66–68; Tables 10–11)

In July and September 1956 two cruises were made with a commercial trawler to search for redfish off south-east Greenland. Some hauls were also made in Icelandic waters; these are the subject of the present note.

Hauls were made at between 225 and 550 m. in different localities off the north-west, west, south-west, and south-east coast of Iceland (see Figure 66). A survey of the length composition of redfish in the north and north-east areas of Iceland in summer 1955 was given in Ann. Biol., XII (1955), pp. 49–52.

In the south-eastern area measurements were made of fish from two catches in depths of 490 and 540 m. The catches in both hauls consisted of the deep-water form of the redfish (*Sebastes marinus mentella*). The redfish from the greater depth (540 m.) were larger than those from other station in the locality (490 m.), the mean lengths being 47.16 cm. and 44.11 cm. respectively.

In the south-western area measurements were made on fish from four catches in depths of 450 and 500 m. In this area, the catches consisted mainly of the *mentella* form, but there were a few of the common form (*Sebastes marinus marinus*).

In the western area measurements were made on fish from four catches. One of them, at 430 m. depth (see Figure 66, G), consisted almost exclusively of the *mentella* form, whereas the other three hauls, made at depths of 225 and 265 m. (two hauls) respectively, were composed of the common form.

In the north-western area, measurements were made on fish from four catches. Two of them were made in the Víkuráll (Figure 66, L and M) in depths of 430 and 460 m. respectively, and were composed chiefly of the *mentella* form. The other two hauls were made further north in about 400 m. depth (see Figure 66, N and O), where only the common form was caught.

In every haul taken in depths greater than 400 m., the *mentella* form predominated, except at Station O. The length distribution of *Sebastes marinus mentella* proved to be almost identical at all stations, with the peak in the 43–45 cm. group, with the exception of Station A, where the maximum was in the 46–48 cm. group (see Table 10). Figure 67 illustrates the length distribution of the

Table 10. Length composition of the deep-water form of the redfish (*S. marinus mentella*) at different localities in Icelandic waters in 1956 (%)

| Stations  | S.E. area |       | S.W. area | W. area | N.W. area | Total  |
|-----------|-----------|-------|-----------|---------|-----------|--------|
|           | A         | B     | C to F    | G       | L and M   | B to M |
| cm. group |           |       |           |         |           |        |
| ≥55       | —         | —     | 1.0       | —       | 3.8       | 1.9    |
| 52–54     | 0.6       | 0.3   | 1.2       | 1.0     | 1.2       | 1.1    |
| 49–51     | 24.9      | 2.9   | 1.7       | 3.2     | 5.2       | 3.4    |
| 46–48     | 59.0      | 29.5  | 13.1      | 18.2    | 23.3      | 19.1   |
| 43–45     | 14.4      | 47.3  | 43.7      | 48.1    | 33.4      | 40.3   |
| 40–42     | 0.9       | 16.7  | 31.7      | 26.3    | 20.7      | 25.5   |
| 37–39     | —         | 1.5   | 6.9       | 2.6     | 9.8       | 7.2    |
| 34–36     | —         | 0.4   | 0.7       | 0.3     | 1.6       | 1.0    |
| 31–33     | —         | 0.3   | —         | 0.3     | 0.7       | 0.3    |
| 30≥       | 0.2       | 1.1   | —         | —       | 0.3       | 0.2    |
| Total ... | 100.0     | 100.0 | 100.0     | 100.0   | 100.0     | 100.0  |
| N .....   | 466       | 275   | 1318      | 308     | 1286      | 3187   |
| M .....   | 47.16     | 44.11 | 43.36     | 43.87   | 44.34     | 43.86  |



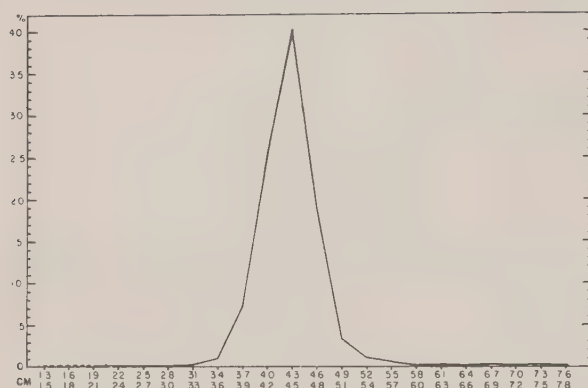


Figure 67. Length distribution of the deep-water form of the redfish (*S. marinus mentella*) for all areas. The curve is based on 3 cm. group intervals.

*mentella* form in all samples, except that from Station A. The 43—45 cm. group made up over 40% of the total.

Catches consisting entirely of the common form were only made in the western and north-western areas at stations where the depth was about 400 m. or less. Samples taken at 225 m. and 265 m. depth in the western area exhibited size differences. The two samples from 265 m. showed the same length distribution, the fish being larger than in the catch from 225 m. (see Figures 66 and 68, H-K, and Table 11).

The length compositions in samples N and O from the north-western area were identical, yet were quite different from the length distribution found in the western area. It may be mentioned that the redfish caught at 390 and 405 m. had an unusual size composition; most of the fish were

Table 11. Length composition of the common form of redfish (*S. marinus marinus*) at different localities in Icelandic waters in 1956 (%)

| Stations<br>Depths, m.<br>cm. group | W. area   |            | N.W. area      | Total |
|-------------------------------------|-----------|------------|----------------|-------|
|                                     | K.<br>225 | H—I<br>265 | N—O<br>390—405 |       |
| ≥70 .....                           | —         | —          | 6.0            | 2.0   |
| 67—69 .....                         | —         | —          | 18.4           | 6.1   |
| 64—66 .....                         | —         | —          | 12.0           | 4.0   |
| 61—63 .....                         | —         | 0.3        | 9.2            | 3.2   |
| 58—60 .....                         | —         | —          | 5.1            | 1.7   |
| 55—57 .....                         | —         | 0.3        | 1.8            | 0.8   |
| 52—54 .....                         | 0.8       | 7.5        | 4.6            | 5.3   |
| 49—51 .....                         | 5.8       | 20.3       | 3.7            | 12.2  |
| 46—48 .....                         | 10.8      | 25.0       | 1.8            | 14.8  |
| 43—45 .....                         | 18.4      | 10.0       | 1.4            | 8.7   |
| 40—42 .....                         | 25.9      | 9.7        | 0.5            | 9.6   |
| 37—39 .....                         | 26.7      | 8.1        | 2.3            | 9.6   |
| 34—36 .....                         | 5.8       | 7.2        | 0.5            | 4.7   |
| 31—33 .....                         | 5.0       | 2.8        | 2.3            | 3.0   |
| 28—30 .....                         | 0.8       | 1.6        | 6.0            | 2.9   |
| 25—27 .....                         | —         | 1.3        | 9.2            | 3.6   |
| 22—24 .....                         | —         | 0.6        | 6.0            | 2.3   |
| 19—21 .....                         | —         | —          | 5.5            | 1.8   |
| 16—18 .....                         | —         | 2.5        | 2.8            | 2.1   |
| 15 ≥ .....                          | —         | 2.8        | 0.9            | 1.6   |
| Total .....                         | 100.0     | 100.0      | 100.0          | 100.0 |
| N .....                             | 120       | 320        | 217            | 657   |
| M .....                             | 41.29     | 42.87      | 49.29          | 45.25 |

very large, with a maximum in the 67—69 cm. group. Smaller sizes were also well represented, with a maximum in the 25—27 cm. group, whereas medium sizes were almost completely lacking (see Figure 68, N—O).

For further discussion of the separation of the *mentella* and common forms and the relation of size to depth more data are required.

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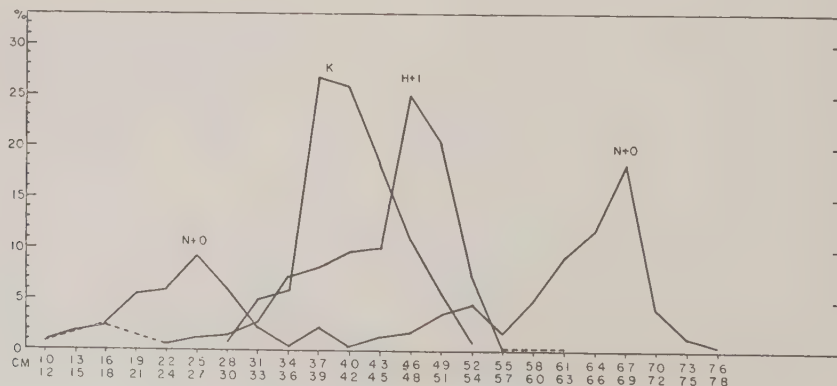


Figure 68. Length distribution of the common form of the redfish (*S. marinus marinus*) from different localities (see Figure 66).

K: Sample from 225 m. depth.  
H—I: Samples from 265 m. depth.  
N—O: Samples from 390 and 405 m. respectively.

|      | Date  | Number<br>of hauls | Length in centimetres |   |    |    |     |     |     |     |     |     |     |     |     |     |     |     |    |    |    |    |  |  |  |  |
|------|-------|--------------------|-----------------------|---|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----|----|----|----|--|--|--|--|
|      |       |                    | 5                     | 6 | 7  | 8  | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  | 21 | 22 | 23 | 24 |  |  |  |  |
| 1952 | May   | 1                  | 1                     | 1 | 1  | 3  | 8   | 24  | 31  | 59  | 69  | 39  | 21  | 18  | 7   | 17  | 29  | 24  | 8  | 24 | 41 | 29 |  |  |  |  |
|      | July  | 2                  | —                     | — | 2  | 2  | 5   | 9   | 20  | 15  | 27  | 22  | 8   | 4   | 2   | 12  | 9   | 9   | 7  | 12 | 15 | 15 |  |  |  |  |
| 1953 | June  | 1                  | —                     | — | 6  | 10 | 23  | 58  | 20  | 15  | 49  | 79  | 88  | 132 | 125 | 83  | 37  | 42  | 26 | 38 | 42 | 28 |  |  |  |  |
|      | Aug.  | 1                  | —                     | — | 6  | 5  | 4   | 13  | 29  | 9   | 21  | 32  | 47  | 68  | 82  | 82  | 38  | 39  | 19 | 42 | 31 | 20 |  |  |  |  |
|      | Oct.  | 1                  | —                     | — | 3  | 14 | 18  | 28  | 36  | 28  | 30  | 54  | 49  | 70  | 96  | 79  | 53  | 30  | 34 | 39 | 35 | 26 |  |  |  |  |
|      | Dec.  | 1                  | —                     | — | 1  | 11 | 19  | 28  | 48  | 49  | 24  | 25  | 40  | 44  | 56  | 27  | 41  | 33  | 15 | 16 | 24 | 15 |  |  |  |  |
| 1954 | Feb.  | 1                  | —                     | — | 1  | 13 | 134 | 207 | 155 | 284 | 239 | 114 | 112 | 204 | 175 | 229 | 184 | 104 | 44 | 37 | 25 | 28 |  |  |  |  |
|      | March | 1                  | 1                     | 5 | 2  | 7  | 31  | 61  | 29  | 24  | 41  | 20  | 8   | 12  | 16  | 12  | 15  | 14  | 3  | 2  | 2  | 4  |  |  |  |  |
|      | April | 1                  | —                     | 1 | 12 | 17 | 74  | 150 | 78  | 44  | 62  | 23  | 19  | 26  | 39  | 48  | 32  | 19  | 6  | 5  | 5  | 1  |  |  |  |  |
|      | May   | 2                  | —                     | — | 1  | 2  | 8   | 22  | 21  | 10  | 11  | 19  | 7   | 7   | 7   | 12  | 11  | 13  | 2  | 2  | 7  | 5  |  |  |  |  |
|      | June  | 2                  | —                     | 2 | 10 | 14 | 8   | 24  | 24  | 17  | 11  | 10  | 6   | 2   | 1   | 2   | 2   | —   | 4  | —  | 1  | 1  |  |  |  |  |
|      | July  | 1                  | 2                     | — | 11 | 26 | 6   | 13  | 27  | 17  | 16  | 12  | 4   | 6   | 16  | 20  | 13  | 16  | 9  | 7  | 7  | 9  |  |  |  |  |
|      | Dec.  | 1                  | —                     | — | 7  | 38 | 58  | 37  | 46  | 95  | 60  | 44  | 80  | 70  | 36  | 39  | 38  | 38  | 34 | 32 | 23 | 15 |  |  |  |  |
|      | May   | 1                  | —                     | — | 3  | 11 | 58  | 109 | 64  | 62  | 100 | 123 | 47  | 58  | 66  | 30  | 30  | 34  | 39 | 54 | 49 | 26 |  |  |  |  |
| 1955 | July  | 2                  | —                     | — | 3  | —  | 9   | 30  | 40  | 22  | 13  | 22  | 25  | 11  | 15  | 18  | 11  | 6   | 9  | 7  | 8  | 10 |  |  |  |  |
|      | Aug.  | 1                  | —                     | — | 5  | 5  | 12  | 50  | 82  | 65  | 34  | 54  | 45  | 46  | 31  | 33  | 17  | 15  | 19 | 20 | 16 | 17 |  |  |  |  |
|      | Sept. | 1                  | —                     | — | 2  | 7  | 11  | 40  | 68  | 175 | 60  | 58  | 119 | 131 | 85  | 75  | 74  | 47  | 43 | 43 | 37 | 42 |  |  |  |  |
|      | Nov.  | 1                  | —                     | — | —  | 4  | 5   | 17  | 44  | 57  | 29  | 42  | 59  | 55  | 37  | 52  | 62  | 40  | 28 | 29 | 39 | 43 |  |  |  |  |
|      | Feb.  | 1                  | —                     | — | 1  | 11 | 44  | 46  | 85  | 161 | 107 | 80  | 94  | 69  | 66  | 51  | 46  | 45  | 24 | 37 | 34 | 46 |  |  |  |  |
| 1956 | May   | 3                  | —                     | — | 3  | 8  | 25  | 36  | 100 | 282 | 315 | 209 | 141 | 194 | 147 | 73  | 72  | 77  | 56 | 25 | 32 | 21 |  |  |  |  |
|      | July  | 1                  | —                     | 1 | 2  | —  | 7   | 12  | 21  | 39  | 95  | 128 | 67  | 49  | 62  | 48  | 49  | 49  | 28 | 39 | 22 | 10 |  |  |  |  |
|      | Oct.  | 1                  | —                     | 1 | 3  | 2  | 1   | 3   | 11  | 26  | 49  | 46  | 48  | 26  | 47  | 46  | 31  | 41  | 27 | 26 | 30 | 25 |  |  |  |  |
|      | Dec.  | 1                  | —                     | — | 4  | 42 | 50  | 17  | 25  | 40  | 59  | 79  | 79  | 33  | 59  | 35  | 31  | 18  | 16 | 14 | 17 | 22 |  |  |  |  |

|      | Date       | Number<br>of hauls | Length in centimetres |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     | Number<br>of fish |
|------|------------|--------------------|-----------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|-------------------|
|      |            |                    | 25                    | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | >40 |                   |
| 1952 | May ....   | 1                  | 35                    | 31 | 23 | 29 | 36 | 50 | 39 | 19 | 9  | 2  | 1  | 1  | —  | 4  | 1  | 1  | 3   | 738               |
|      | July ....  | 2                  | 10                    | 9  | 9  | 5  | 2  | 12 | 3  | 2  | —  | 1  | 1  | 1  | —  | 2  | —  | 1  | 9   | 265               |
| 1953 | June ....  | 1                  | 35                    | 43 | 52 | 27 | 21 | 17 | 10 | 22 | 28 | 19 | 12 | 20 | 20 | 24 | 15 | 17 | 46  | 1,329             |
|      | Aug. ....  | 1                  | 22                    | 34 | 35 | 18 | 6  | 6  | 7  | 2  | 4  | 3  | 1  | 2  | 2  | —  | 1  | 3  | 4   | 738               |
|      | Oct. ....  | 1                  | 23                    | 31 | 41 | 23 | 9  | 11 | 10 | 7  | 13 | 2  | 8  | 6  | 6  | 3  | 7  | 2  | 5   | 929               |
|      | Dec. ....  | 1                  | 14                    | 17 | 17 | 14 | 2  | 5  | 5  | 3  | 4  | 3  | —  | 3  | 1  | 1  | 1  | —  | 6   | 612               |
| 1954 | Feb. ....  | 1                  | 30                    | 19 | 30 | 28 | 24 | 27 | 19 | 26 | 25 | 21 | 12 | 11 | 4  | 10 | 5  | 4  | 12  | 2,596             |
|      | March ...  | 1                  | 2                     | 2  | —  | 1  | 4  | 2  | 1  | —  | —  | 1  | 1  | —  | 1  | 2  | —  | 2  | 3   | 331               |
|      | April .... | 1                  | 1                     | 5  | 3  | 4  | 3  | 6  | 6  | 6  | 5  | 3  | 2  | —  | 1  | 2  | —  | 1  | —   | 708               |
|      | May ....   | 2                  | 1                     | 3  | 6  | 7  | 3  | —  | 2  | 1  | —  | 1  | —  | 1  | 2  | —  | —  | 1  | 2   | 197               |
|      | June ....  | 2                  | 1                     | 1  | 3  | 1  | 1  | —  | 2  | 1  | —  | —  | —  | —  | 1  | —  | —  | 1  | 1   | 152               |
|      | July ....  | 1                  | 2                     | 4  | 5  | 6  | 4  | 10 | 6  | 9  | 1  | 2  | 6  | —  | 6  | 5  | 3  | 5  | 7   | 318               |
|      | Dec. ....  | 1                  | 12                    | 15 | 7  | 5  | 3  | 3  | 1  | 1  | 1  | —  | —  | —  | 1  | —  | 1  | 1  | 4   | 845               |
|      | May ....   | 1                  | 24                    | 14 | 9  | 11 | 9  | 5  | 5  | 8  | 6  | 3  | 3  | 3  | 3  | —  | 2  | 1  | 5   | 1,074             |
| 1955 | July ....  | 2                  | 5                     | 4  | 1  | 1  | 1  | 2  | —  | —  | 1  | —  | —  | —  | 1  | 1  | —  | —  | 2   | 277               |
|      | Aug. ....  | 1                  | 9                     | 5  | 7  | 4  | —  | 2  | 4  | 1  | 2  | 5  | 3  | 2  | 3  | 2  | 2  | 3  | 2   | 622               |
|      | Sept. .... | 1                  | 21                    | 12 | 7  | 7  | 4  | 9  | 3  | 3  | 5  | 6  | 6  | 1  | 7  | 6  | 3  | 2  | 7   | 1,226             |
|      | Nov. ....  | 1                  | 46                    | 18 | 15 | 11 | 10 | 8  | 4  | 6  | 3  | 7  | 6  | 4  | 3  | 8  | 4  | 3  | 8   | 806               |
|      | Feb. ....  | 1                  | 39                    | 27 | 26 | 30 | 17 | 17 | 10 | 17 | 12 | 16 | 18 | 14 | 18 | 11 | 2  | 5  | 11  | 1,337             |
| 1956 | May ....   | 3                  | 25                    | 25 | 4  | 3  | 5  | 3  | 3  | 7  | 7  | 7  | 9  | 9  | 8  | 15 | 14 | 17 | 28  | 2,005             |
|      | July ....  | 1                  | 9                     | 9  | 8  | 2  | —  | —  | —  | 1  | —  | 3  | 4  | 2  | —  | —  | —  | 4  | 1   | 771               |
|      | Oct. ....  | 1                  | 27                    | 23 | 20 | 12 | 6  | 5  | —  | 3  | 1  | 1  | 4  | 2  | 1  | 2  | 2  | —  | 15  | 613               |
|      | Dec. ....  | 1                  | 37                    | 46 | 28 | 16 | 5  | 5  | 5  | —  | 1  | 1  | 1  | —  | —  | —  | —  | —  | —   | 785               |

(Tables 12 and 13)

No detailed work has yet been carried out on *Sebastes marinus* in the West Greenland area. Otolith samples and length measurements have been collected from catches made mainly with shrimp trawls. Most of the measurements were

made on catches from a small area of Pisigsarfik, a branch of the Godthâb Fjord, at 250 m. depth. A total of 19,274 redfish, from 29 hauls, was measured between 1952 and 1956. The records are given in Table 12.

In August 1930, in the Julianehåb district large numbers of small redfish were found floating on the surface dead and dying. Thirty-eight of these

Table 13. Length frequencies of redfish taken with the shrimp trawl by M/C "Immanuel" in Tunugdliarfik Fjord, 60°56'N., 45°47'W.

|      |              | Number   | Length in centimetres |    |    |    |    |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |  |  |  |
|------|--------------|----------|-----------------------|----|----|----|----|-----|-----|-----|-----|-----|-----|----|----|----|----|----|----|----|----|----|--|--|--|
| Date |              | of hauls | 5                     | 6  | 7  | 8  | 9  | 10  | 11  | 12  | 13  | 14  | 15  | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |  |  |  |
| 1955 | . Sept. .... | 1        | —                     | —  | —  | 1  | 3  | 13  | 17  | 18  | 12  | 2   | 5   | 2  | —  | 3  | 1  | 4  | 2  | 2  | 2  | 3  |  |  |  |
|      | . Oct. ....  | 1        | —                     | —  | —  | —  | 4  | 5   | 26  | 48  | 51  | 26  | 22  | 24 | 15 | 9  | 3  | 6  | 4  | 3  | 8  | 4  |  |  |  |
| 1956 | . Feb. ....  | 1        | —                     | 11 | 17 | 14 | 39 | 24  | 12  | 34  | 49  | 24  | 20  | 21 | 14 | 7  | 3  | 8  | 4  | 3  | 4  | 4  |  |  |  |
|      | . April .... | 1        | —                     | 2  | 3  | 6  | 7  | 18  | 13  | 14  | 27  | 30  | 26  | 20 | 25 | 23 | 14 | 14 | 19 | 15 | 11 | 7  |  |  |  |
|      | . May ....   | 1        | —                     | 2  | 2  | 6  | 4  | 9   | 6   | 4   | 13  | 6   | 3   | 2  | 1  | —  | 2  | 1  | —  | —  | —  | 1  |  |  |  |
|      | . June ....  | 2        | —                     | 2  | 17 | 20 | 14 | 11  | 13  | 10  | 16  | 15  | 5   | 3  | 6  | —  | 3  | 1  | —  | —  | 2  | —  |  |  |  |
|      | . July ....  | 3        | —                     | 6  | 20 | 27 | 81 | 133 | 142 | 169 | 220 | 173 | 106 | 55 | 33 | 33 | 17 | 15 | 15 | 14 | 10 | 4  |  |  |  |
|      | . Aug. ....  | 1        | —                     | —  | 3  | 10 | 10 | 21  | 30  | 17  | 14  | 20  | 19  | 13 | 6  | 5  | 2  | 1  | 5  | 3  | 1  | 1  |  |  |  |
|      | . Sept. .... | 1        | —                     | 1  | 1  | 6  | 7  | 10  | 14  | 11  | 6   | 7   | 12  | 4  | 2  | 7  | 1  | 2  | 1  | 2  | —  | 1  |  |  |  |
|      | . Oct. ....  | 1        | —                     | 1  | 6  | 18 | 28 | 18  | 32  | 20  | 28  | 30  | 20  | 14 | 6  | 5  | 8  | 2  | 2  | 1  | 1  | 4  |  |  |  |

|      |              | Number   | Length in centimetres |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     | Number  |
|------|--------------|----------|-----------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|---------|
| Date |              | of hauls | 25                    | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | >40 | of fish |
| 1955 | . Sept. .... | 1        | 1                     | 6  | 8  | 14 | 10 | 11 | 6  | 12 | 18 | 7  | 4  | 7  | 2  | —  | —  | —  | —   | 196     |
|      | . Oct. ....  | 1        | 3                     | 5  | 2  | 4  | 4  | 7  | 6  | 3  | 4  | 7  | 2  | 4  | —  | 1  | 1  | —  | —   | 314     |
| 1956 | . Feb. ....  | 1        | 3                     | 1  | 3  | 3  | 3  | 6  | 2  | 4  | —  | 4  | 3  | 4  | 1  | —  | —  | —  | 2   | 351     |
|      | . April .... | 1        | 5                     | 7  | 4  | 7  | 2  | 5  | 6  | 9  | 12 | 7  | 1  | 2  | 4  | 4  | 2  | 2  | 2   | 375     |
|      | . May ....   | 1        | 2                     | —  | —  | —  | 2  | 1  | 1  | 1  | —  | 1  | 1  | —  | 1  | —  | —  | —  | —   | 72      |
|      | . June ....  | 2        | —                     | 1  | 1  | 1  | 2  | 8  | 7  | 6  | 2  | 6  | 4  | 1  | 1  | 2  | —  | —  | —   | 180     |
|      | . July ....  | 3        | 15                    | 12 | 22 | 26 | 36 | 41 | 45 | 42 | 35 | 36 | 23 | 20 | 3  | 3  | 2  | —  | 5   | 1,639   |
|      | . Aug. ....  | 1        | 3                     | 5  | 3  | 3  | 12 | 7  | 7  | 11 | 10 | 5  | 8  | 5  | 1  | —  | —  | —  | —   | 261     |
|      | . Sept. .... | 1        | 3                     | —  | 2  | 3  | 2  | 10 | 13 | 3  | 5  | 2  | 4  | 1  | 2  | 2  | —  | —  | 1   | 148     |
|      | . Oct. ....  | 1        | 3                     | 1  | 1  | 3  | 4  | 4  | 3  | 2  | 2  | 1  | 1  | 1  | —  | —  | —  | —  | —   | 270     |

small redfish were measured and the mean length found to be 35.6 mm.; these fishes evidently belonged to the 0-group. On 18. September 1951 a number of small redfish were collected in the Julianehåb district from cod stomachs. Their mean length was 43.6 mm. This gives reason to think that 0-group fish reach a length of about 4 cm. It appears from the table that the smallest specimens taken with the shrimp trawl (mesh size 20 mm.) were 5 cm. in length (May 1952). These small fish must belong to the I-group.

In Table 12 first the distinct maximum is found at 8 cm. which probably represents individuals of the II-group. By considering the peaks in the curves for the different catches, we may obtain a rough idea of the growth of the earlier age-groups of redfish. For instance, the peak at 8 cm. in June 1954 seems to be traceable in the samples until December 1956. In July 1954 the peak is still at 8 cm., but in December the same year it is at 9 cm. By May 1955 the peak has reached 10 cm., 11 cm. in July and August, and 12 cm. in September. In February 1956 the peak is still at 12 cm., which indicates that no growth has taken place during

winter. In May, July, and December the peak occurs at 13, 14, and 15 cm. respectively. This suggests that the mean lengths of redfish of age-groups I, II, III, and IV are approximately 4—5, 8—9, 10—12, and 12—15 cm. respectively, which means a yearly growth increment of 2 to 3 cm. If the maximum at 10 cm. in March 1954 is similarly followed to December 1956, the growth-rate found is much the same. The growth-rate of the stock of redfish in the Godthåb Fjord accordingly seems to be very low.

Measurements of 3,806 small redfish are recorded in Table 13. These fish were caught in 13 shrimp-trawl hauls in Tunugdliarfik Fjord in the Julianehåb district in 1955 and 1956. Too few fish were measured in each catch and the catches were taken over too short a period for estimates of growth-rate to be made. A few measurements of redfish taken with the shrimp trawl in Godthåb Fjord and Tunugdliarfik were made before 1952 and are not worth tabulating here.

It has been planned to continue these trawling experiments in the future.

PAUL M. HANSEN



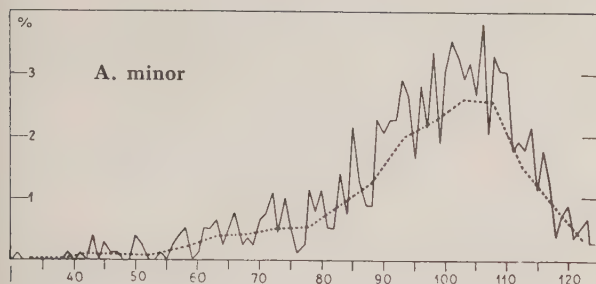


Figure 69.

## Wolffish

Spotted Wolffish (*Anarhichas minor*) and Striped Wolffish (*Anarhichas lupus*)

(Figures 69—71)

The spotted wolffish has become of increasing importance in the fishery carried on by the Greenlanders in the last three years. The annual output of the fishery in metric tons is as follows:— 1952, 626 tons; 1953, 1,987 tons; 1954, 2,434 tons; 1955, 3,400 tons; 1956, 3,510 tons.

Experimental fishing with long-lines was carried out by the "Adolf Jensen" in 1956, to find new wolffish grounds in inshore waters between 64° and 67°N. Length frequency curves from the wolffish measurements made during these experiments are given in Figures 69 and 70.

Figure 69 shows the length frequencies of 786 *A. minor* and Figure 70 shows the length frequencies of 174 *A. lupus*. The dotted lines in the figures show the length frequencies in 5 cm. groups. There is a great difference in size between the two species. It is interesting that very few specimens have been

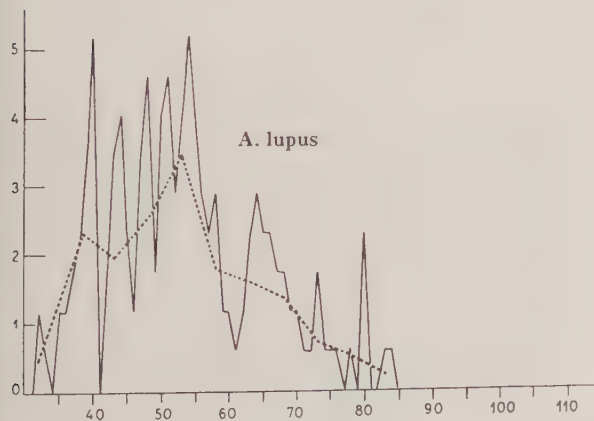


Figure 70.

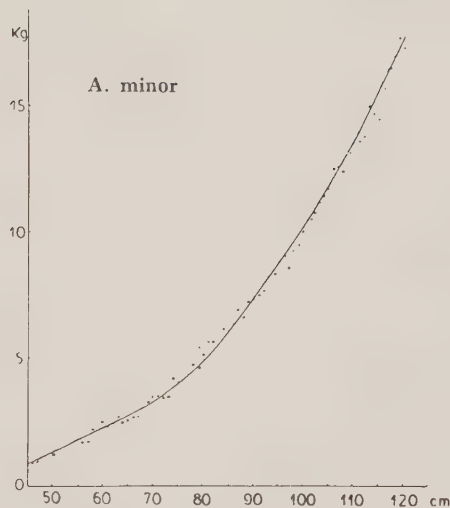


Figure 71.

caught of *A. minor* below 80 cm. in total length. A large collection of otoliths and measurements of both species has been made but has not yet been worked up.

The graph in Figure 71 shows the relation between length and weight for *A. minor*.

Tagging with ebonite disks in the dorsal fin has been carried out on 644 fish of the two species.

PAUL M. HANSEN

## Rare Fish from Distant Northern Seas

## Germany

The number of rare fish recorded in 1956 was smaller than in the previous year. Of the nine species taken, two were received by the "Institut für Meeresforschung", Bremerhaven, and identified by Dr. BRANDES; the rest were dealt with by the "Abteilung Fischereibiologie der Biologischen Anstalt Helgoland", Bremerhaven, and were identified by Dr. KOTTHAUS. No records were received from the "Institut für Seefischerei", Hamburg.

1. *Argyropelecus olfersi* (CUVIER 1829)

KOTTHAUS ident.

5. 4. 1956, Iceland-Faroe Ridge ("Rosen-garten"), 1, 19 cm., taken by commercial trawler.

2. *Artediellus uncinatus* (REINHARDT 1833)

KOTTHAUS ident.

1. 5. 1956, 62° 56' N., 10° 12' W., 480 m., 1, 11 cm., taken by "Anton Dohrn".

3. *Careproctus gelatinosus* (PALLAS 1769)  
KOTTHAUS ident.  
2. 5. 1956, 63°05'N., 12°22'W., 455 m.,  
1, 19 cm., taken by "Anton Dohrn".
4. *Centrolophus niger* (GMELIN 1788)  
BRANDES ident.  
4. 4. 1956, Iceland, S.W. coast, 1, 35 cm.,  
taken by commercial trawler.
5. *Coryphaenoides rupestris* GUNNERUS 1765  
KOTTHAUS ident.  
1. 5. 1956, 62°56'N., 10°12'W., 480 m.,  
2, ♀ VII 90 cm. and ♀ VII 97 cm., taken by  
"Anton Dohrn".  
7. 5. 1956, 63°10'N., 20°28'W., 295 m.,  
1, 50 cm., taken by "Anton Dohrn".
6. *Helicolenus dactylopterus* (DE LA ROCHE 1810)  
KOTTHAUS ident.  
1. 5. 1956, 62°16'N., 08°49'W., 300 m.,  
2, 16 and 17 cm., taken by "Anton Dohrn".
7. *Lycodes esmarkii* COLLETT 1874  
KOTTHAUS ident.  
1. 5. 1956, 62°03'N., 09°21'W., 500 m.,  
1, 49 cm., taken by "Anton Dohrn".  
1. 5. 1956, 62°48'N., 09°18'W., 450 m.,  
1, 50 cm., taken by "Anton Dohrn".  
3. 5. 1956, 63°17'N., 10°20'W., 365 m.,  
1, ♀ 52 cm., taken by "Anton Dohrn".
8. *Notacanthus phasgonorus* GOODE 1881  
BRANDES ident.  
20. 5. 1956, W. Greenland, Fiskenæs Bank,  
1, ♀ 96 cm., taken by commercial trawler.

9. *Polyprion americanum* (BLOCH 1801)  
KOTTHAUS ident.  
January 1956, off Lofoten, 1, 54 cm., taken  
by commercial trawler.

C.-H. BRANDES, A. KOTTHAUS

#### Scotland

Fishing with great-lines in 500 fathoms at 60°48'N., 11°28'W. on 21. July 1956 a research vessel caught a number of small sharks and dog-fishes which included the following species:—

*Etmopterus princeps* COLLETT, one female of 70 cm.  
*Centroscyllium fabricii* (REINHARDT), one female of 86 cm.

*Centroscymnus coelolepis* BOCAGE & CAPELLO, 8 males, 87 to 99 cm. and 5 females, 92 to 128 cm.  
*Deania* sp., one male of 86 cm.

On another research cruise a specimen of *Fierasfer dentatus* CUVIER, was caught in Icelandic waters, 63°30'N., 16°04'W., on 31. August. As this species is not included in SAEMUNDSSON's list of marine fishes at Iceland this would appear to be a first record for that country.

The following unusual records were obtained from commercial vessels in 1956.

*Somniosus microcephalus* (SCHNEIDER), one young male, 3.43 m., trawled on Fuglø Bank, Faroe, 21. February.

*Brama raii* (BLOCH), one specimen by great-line on Syderø Bank in September.

B.B. RAE, E. WILSON

## Near Northern Seas

### INTRODUCTION

Contributions to this report have been received from :—

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England:  
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E. GOEDECKE  
A. KOTTHAUS  
W. KRAUSS

G. KREFFT  
P. F. MEYER-WAARDEN  
G. PRAHM  
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Scotland:  
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#### A. Environment

There are unfortunately no hydrographical observations available from the Irish Sea and the waters off the west coast of Scotland to compare with the 1955 observations. There are, however, observations from the Clyde area in November showing a well-marked hydrographic boundary over the ridge across the outer part of the Firth.

The Scottish observations show that, as in 1955, there was a very moderate oceanic influx into the northern North Sea. The temperatures at both surface and bottom were low, with a less sharply marked thermocline than usual. The surface stream of diluted water from the land was less

distinct than usual, probably on account of the prolonged drought in 1955. The less well marked thermocline in late summer 1956 was associated with higher phosphate values west of the prime meridian and the phosphate situation contrasted strongly with that in 1955.

The hydrographical situation in the northern North Sea and Norwegian Rinne during the latter half of February and the first week of March is described in the German report.

The Danish observations made on three long cruises agree on the whole with those from Scotland and show, *inter alia*, that the temperature on the Bløden Ground was very low in spring and early summer. In autumn the mixing of the water masses took place about one month earlier than normal. Some sections also demonstrate the presence of strong stratification north of the Dogger Bank and a heavy outflow from the Baltic.

A more instantaneous picture of the hydrographical situation between 3° and 4°E. from 2. to 4. September is given by one of the German sections and it agrees with the Danish section as regards the stratification north of the Dogger Bank and the presence of cold bottom water, but it also shows a similar situation south-east of the Dogger Bank. Of the two cold bottom water masses the northern was unusually cold compared with previous years. The temperature of the south-eastern cold water and its distribution may very well influence the fisheries in that area.

The German surface observations in the German Bight show that the temperature was



about normal in January and from October to December but relatively low from February to September compared with the monthly means for 1950—1954. Surface observations have been made on the Hamburg-Hull route during the period 1953—1956 and the monthly mean values for temperature and salinity are reported. The monthly mean values for 1956 compared with those for the period 1902—1928 show that the surface water was abnormally warm in January and from October to December and abnormally cold in nearly all the other months.

There is also a report on the bottom temperatures in summer for the period 1900 to 1956 for two selected areas in the central North Sea. This supplements the reports and shows the variability of the bottom temperature from year to year. The temperatures in 1955 and 1956 were the lowest in the above-mentioned period.

The extremely low surface temperature which prevailed in the Skagerak and Kattegat is shown by the values from Flødevigen in Norway and the reports dealing with Danish and Swedish waters, the Kattegat being covered with ice from the beginning of February to the beginning of March.

The spring production of phytoplankton seems to have been greater in 1956 than in 1955; 1955 had the greater autumn production. The moderate inflow of oceanic water into the North Sea was also reflected in the zooplankton catches; there was some incursion of oceanic species round the north of Shetland and also through the Fair Isle Passage in spring. In summer an incursion occurred

in subsurface waters east of 3°E. and there was a slight trickle of immigrants through the Fair Isle Passage. In autumn the inflow of oceanic species was still slight.

Of special interest are the cruises planned to follow a small concentration of newly hatched herring larvae during their planktonic phase.

## **B. The Fish**

**Eggs and Larvae.** No reports received.

**Plaice.** From 1956 onwards the German plaice investigations are being changed and extended so that the area covered comprises the whole south-eastern North Sea. The trawl used is now one with a covered cod-end, which renders the old data from previous cruises not directly comparable with the new. In 1955 a decline apparently occurred in the plaice stock in the German Bight and this is borne out by the 1956 results. The 1952 and 1953 year-classes were the richest after 1947 and the 1954 year-class seems to be of more than medium strength. There will thus be a succession of three good year-classes available. In the landings at Esbjerg the predominance of the 1952 year-class was even more apparent than in 1955. In the central Kattegat the stock seems to have been a little denser in 1956 than in 1955, as was also the case with the dab in the Kattegat.

**Industrial fisheries.** Two German investigations give figures for the occurrence of protected fish in the "oil herring" catches and in landings from shrimpers.

J. HULT

## ENVIRONMENT

### Hydrography

#### Near Northern Seas and Approaches

(Tables 1-2)

The extent of Scottish hydrographic observations in 1956 is indicated in Table 1, detailing the nature and numbers of observations made in the North Sea, Faroe-Shetland Channel, Iceland, and N.E. Atlantic Ocean waters.

Considering, in the main, the oceanic as the major water mass influencing these regions, preliminary survey of the material indicates a gradual recession of this influence in the northern North Sea and the Faroe-Shetland Channel during at least the first quarter of the year, from a maximum incursion of the water-mass into these regions in December 1955.

Dynamic assessment of the Atlantic Current in the Faroe-Shetland Channel was not achieved before mid-July when the volume transport then worked out at only about 4—5 km.<sup>3</sup>/hr. One month later the value apparently was about 16—17 km.<sup>3</sup>/hr. and in the second week of September had evidently dropped to approximately 14 km.<sup>3</sup>/hr. By mid-November 1956, however concordant results on a double traverse of the Channel showed the maintenance at least of the enhanced oceanic incursion of the early autumn.

Supporting as well as additional information is contained in the results of surface drift-bottle liberations made in 1956. These are detailed in Table 2.

Taking, first, the North Sea liberations, which began only in March, the recoveries therefrom show a preponderance of Skagerak and the North Sea Norwegian coast returns, as well as of Norwegian coast strandings outside the North Sea which is a normal annual occurrence. A few recoveries were effected on the Danish west coast south of the Skagerak. These occurred, almost singly, in the months of May, June and July, and were scarcely outwith the entrance to the Skagerak. Then, after a gap of three months, came three more in this class of return, in November and December 1956, from more southerly latitudes on the west Danish coast, more specifically indicative of pressure from the north directed southwards into the North Sea, presumably by oceanic water-mass incursion, towards the end of the year. This is supported by analysis of the Skagerak returns which show a preponderance in December 1956, and a secondary maximum in October after a blank month and only very few returns in July and August. September returns came mostly from the North Sea Norwegian coast.

It would appear, however, from drift-bottle records that a very moderate accession to the strength of oceanic incursion into the North Sea occurred in May 1956, throwing a significant number of drifters on to the North Sea Norwegian coast in that month, but by all the evidence this incursion receded during July and August.

Table 1. Scottish hydrographic observations, 1956

| Vessel             | Hydrographic stations | Temp. observations | Salinity observations | Oxygen observations | Phosphate |       | Drift-Bottles |            |
|--------------------|-----------------------|--------------------|-----------------------|---------------------|-----------|-------|---------------|------------|
|                    |                       |                    |                       |                     | Free      | Total | Liberations   | Recoveries |
| "Scotia" . . . . . | 193                   | 1376               | 1431                  | 472                 | 821       | 6     | 455 }         | 165        |
| "Explorer" . . . . | 244                   | 1683               | 1640                  | 657                 | 973       | 12    | 625 }         |            |
| "Clupea" . . . . . | 412                   | 1444               | 1258                  | 8                   | 690       | —     | —             | —          |
| "Kathleen" . . . . | 7                     | 14                 | 14                    | —                   | —         | —     | —             | —          |
| Weather Ships . .  | —                     | —                  | —                     | —                   | —         | —     | 840           | 71         |
|                    | 856                   | 4517               | 4343                  | 1137                | 2484      | 18    | 1920          | 236        |

Table 2. Drift-bottles at weather stations "J" (A) and "I" (B) in the Faroe-Shetland Channel and N.E. Atlantic Ocean (C) and in the North Sea (D), 1956

|         | Liberations<br>No. of<br>drifters | Recoveries<br>Frequency-distribution <sup>1)</sup> |    |   |   |   |   |    |    |    |    |    |    |    |     | Totals |
|---------|-----------------------------------|----------------------------------------------------|----|---|---|---|---|----|----|----|----|----|----|----|-----|--------|
|         |                                   | 0                                                  | 1  | 2 | 3 | 4 | 5 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |     |        |
| A ..... | 440                               | 26                                                 | 11 | — | — | — | — | —  | —  | —  | —  | —  | —  | —  | 37  |        |
| B ..... | 400                               | 3                                                  | 6  | 3 | 4 | — | — | —  | 2  | 4  | 10 | 1  | —  | 1  | 34  |        |
| C ..... | 455                               | —                                                  | 2  | 7 | 3 | — | — | —  | 1  | —  | 12 | —  | —  | —  | 25  |        |
| D ..... | 625                               | —                                                  | —  | 1 | — | 1 | 1 | 8  | 37 | 40 | 52 | —  | —  | —  | 140 |        |

<sup>1)</sup> Definition of the column numbers is given in a footnote p. 94 of Ann. Biol., VIII (1951).

Turning to the Faroe-Shetland Channel and N.E. Atlantic Ocean liberations, exclusive of those from the weather stations, only a single drifter apparently entered the North Sea, stranding on the Skagerak in December. All twelve of the extra-North Sea Norwegian strandings from these liberations between July and November 1956, inclusive, stranded in the months of December 1956, January and February 1957. Likewise the ten similar returns from Weather Ship "I" liberations from January to December 1956 took place in the same months except February 1957. It is noteworthy, however, that in the same months two Skagerak and three of the four North Sea Norwegian recoveries from these liberations were recorded.

From the more southerly weather station "J" all 37 recoveries took place on the west coasts of Ireland and of Scotland. There were no French coast recoveries from these liberations such as occurred in 1950 and in 1954, and no bottles from these liberations have been notified as having reached Norwegian shores either outwith or within the North Sea.

J. B. TAIT

## Surveys in Scottish Coastal Waters

### The Firth of Forth, February 1956 (Figure 1)

The charts are derived from sixty-four stations at which observations were made at surface and bottom only. This survey took place at the end of a period of unusual drought. The general impression is that the surface stream of diluted water is much less distinctive than usual. In fact vertical mixing must have been extensive and the surface and bottom distributions are more alike than is typical for this region. A comparison, in the case of the outer Firth, may be made with earlier results (see CRAIG, *Ann. Biol.*, VIII, pp. 98—99, 1952).

### The Clyde area, November 1956 (Figure 2)

The charts show surface temperature and turbidity as measured by unfiltered tungsten light in a meter towed at four metres depth. The units are the absorption constant per metre.

The temperature and salinity section lies S.S.W.-N.N.E. across the ridge which lies across the outer part of the Firth. The section shows clearly that there is a well marked hydrographic boundary over this ridge, Clyde water lying in a wedge extending outwards for about five miles over

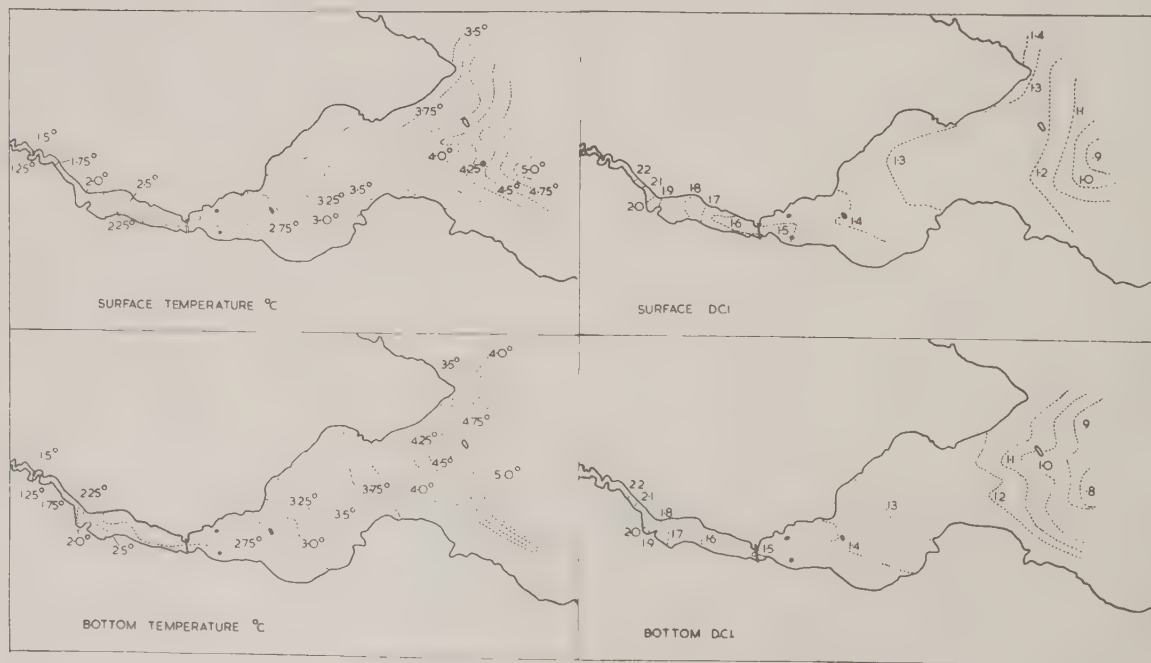


Figure 1. Charts showing the distribution of temperature and salinity (expressed as D.C.I.) for the Firth of Forth 22.—24. February 1956.



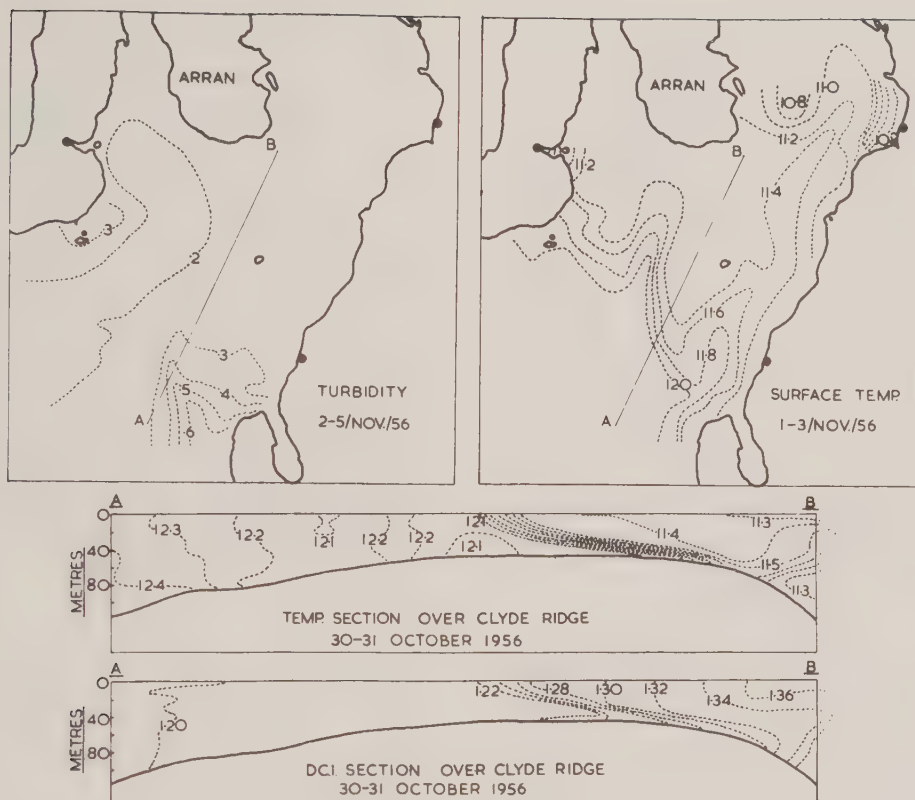


Figure 2. Charts of turbidity at 4 m. depth and surface temperature for the Firth of Clyde 1.—5. November 1956, and temperature and D.C.I. values in a hydrographic section across the ridge at the entrance to the Firth of Clyde.

the North Channel water. Repetition of this section two weeks later showed a similar distribution of water masses.

R. E. CRAIG

### Chemical Observations

(Figures 3-10)

Scottish research vessels "Explorer" and "Scotia" made four surveys of the northern North Sea in 1956. Two of the cruises were in the spring, one in late summer, and the last in the autumn. Chemical data for these cruises are presented in this report; collateral information on temperature and salinity (as D.C.I. values) have been included in this volume by R. E. CRAIG (p.62).

#### Early spring (Figs. 3 and 4)

Although this cruise took place approximately two weeks later than the corresponding one in 1955 (BURNS, 1956<sup>1</sup>) Figs. 3 and 4, which show dissolved oxygen and free phosphate concentrations in the

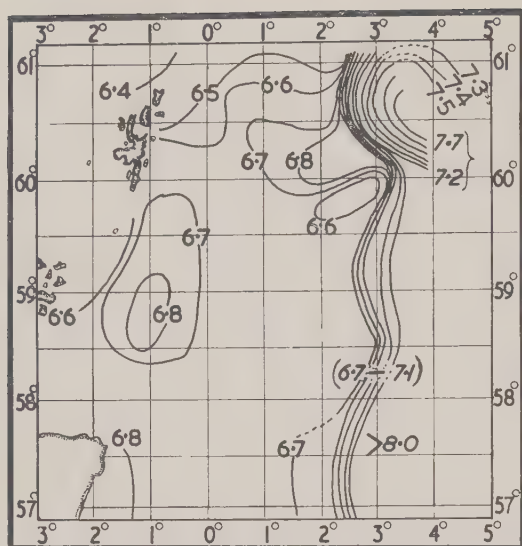
surface respectively, are remarkably similar to those of 1955. Oxygen saturation values varied from 101 to 117% in Norwegian coastal water; 101 to 102% in Scottish coastal water, and 98 to 100% elsewhere.

#### Spring (Figs. 5 and 6)

The spring outburst induces rapid chemical changes at this time of year, and the transitory character of the distributions illustrated needs to be borne in mind. The order of sampling was roughly from south to north, and Figure 5 is based on fewer values than were available for Figure 6.

Figure 5 shows that the main phytoplankton production was then occurring in the coastal regions off Orkney and Shetland and in the zone west of the Norwegian deeps enclosed by the 7.5 isoline for oxygen. In these regions of very active production, oxygen saturation values between 107 and 121% were recorded. Within the 7.0 cc./l. isoline the oxygen saturation value lay between 104 and 107%; elsewhere it was 108 to 115%.

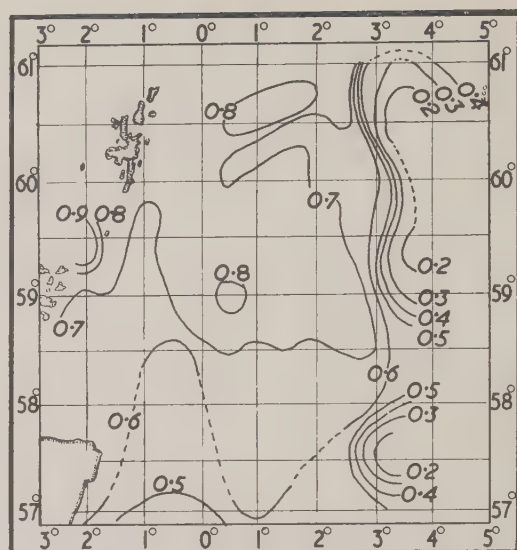
<sup>1</sup>) Ann. Biol., XII (1955).



DISSOLVED OXYGEN, c.c.s/l. Surface.

3.4.56-16.4.56

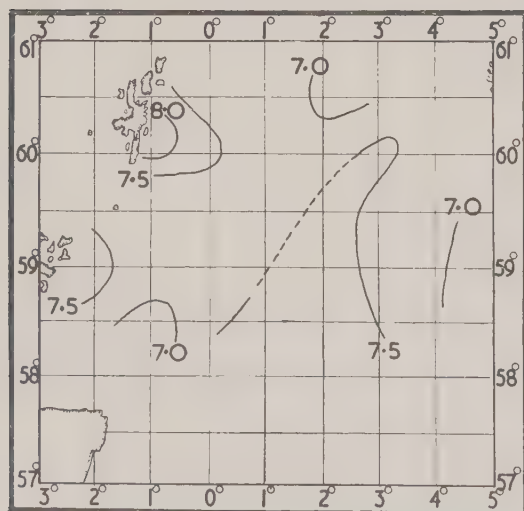
Figure 3



FREE PHOSPHATE,  $\mu\text{gm-at.PO}_4\text{-P/l.}$  Surface.

3.4.56-16.4.56

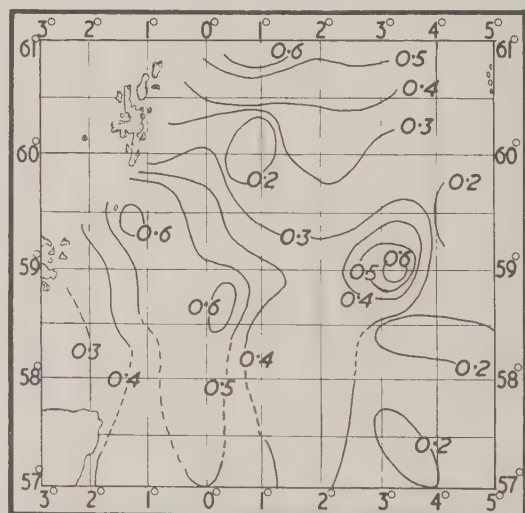
Figure 4.



DISSOLVED OXYGEN, c.c.s/l. Surface.

21.4.56-13.5.56

Figure 5.



FREE PHOSPHATE,  $\mu\text{gm-at.PO}_4\text{-P/l.}$  Surface.

21.4.56-13.5.56

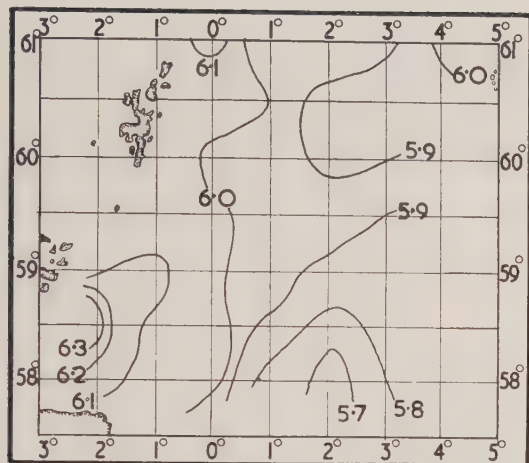
Figure 6.

Figure 6 shows that, in addition to the depleted Norwegian coastal zone, a belt of low phosphate had developed across the 60°N. parallel, while the oxygen saturation had increased since the earlier survey from 98 to 115%. Water in this region was found to have increased vertical stability due to a thermal gradient of 2° between the 10 and 30 m. depths, whereas the surrounding area showed much smaller thermoclines. High phosphate values

north of 60°30'N. probably accompanied a local increase in the influx of Atlantic water. This water with a salinity greater than 35.30‰ lay along 61°N. lat. up to the 3°E. long.

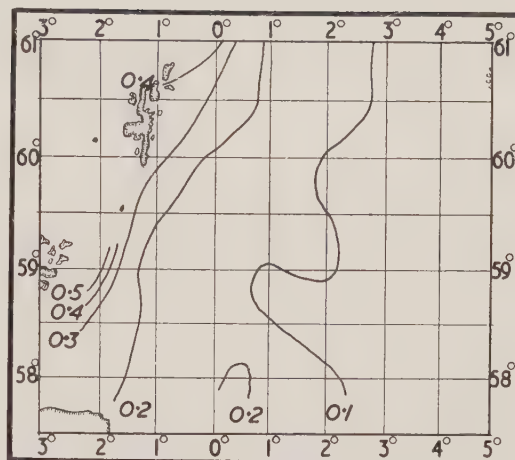
#### Late summer (Figs. 7 and 8)

This cruise covered almost the same period as the one last year, and precise comparison may be made.



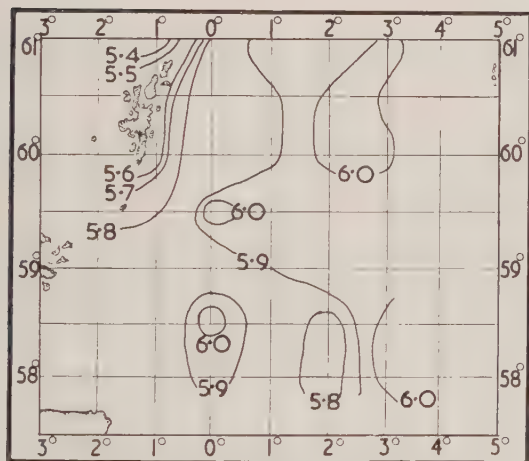
DISSOLVED OXYGEN, cc.s/l. Surface.  
26.7.56-10.8.56

Figure 7.



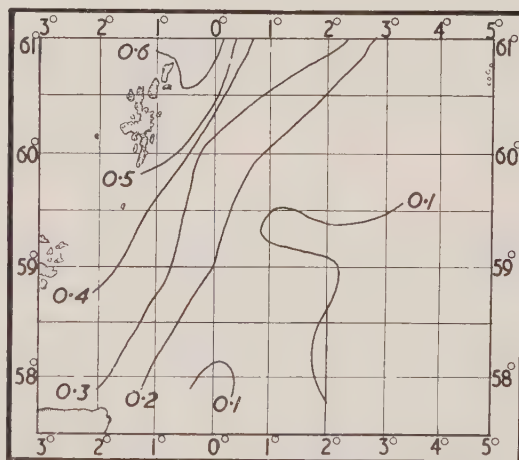
FREE PHOSPHATE,  $\mu\text{gm.at.PO}_4\text{-P/l. Surface.}$   
26.7.56-10.8.56

Figure 8.



DISSOLVED OXYGEN, cc.s/l. Surface.  
27.9.56-11.10.56

Figure 9.



FREE PHOSPHATE,  $\mu\text{gm.at.PO}_4\text{-P/l. Surface.}$   
27.9.56-11.10.56

Figure 10.

The phosphate distribution (Fig. 8) contrasts strongly with that found in 1955 when conditions accompanying the strong thermocline set up over the northern North Sea, caused the surface layers to become almost totally depleted of nutrients. Figure 8 shows that a comparable environment existed only in the eastern half of the area. West of the prime meridian the phosphate values were almost as high as those found in June 1955, and were associated with only slight thermal discontinuity.

Although Atlantic water of salinity greater than 35.3‰ occupied a smaller area to the north of Shetland, the water to the south-east of Fair Isle where the highest phosphate values were found, was appreciably more saline than in 1955. A contributory factor may have been the drought experienced in the British Isles during the previous months.

Oxygen values east of 2°E. (Fig. 7) were of the same magnitude as in 1955. In terms of saturation the values were between 100 and 102% where



the phosphate value was less than 0.1 units; between 103 and 105‰ where the value was 0.1–0.2 units, and between 104 and 108‰ in the coastal zones of Orkney and Shetland.

#### Autumn (Figs. 9 and 10)

Chemical data for autumn have not been previously presented. The chief difference between the values for September/October and August are in the oxygen saturation values. Decreased saturation is partly due to the fall in temperature which ranged from about 1°C. in the north-west to 2°C. in the south-east. Within the regions of higher oxygen values (5.9–6.0 cc./l., Fig. 9) the saturation value was 100–102‰; elsewhere it lay between 97 and 100‰.

Water of salinity less than 35.00‰ extending from the Norwegian coast was confined east of the 3°E. in April. By August it had spread to 2°E., and in October it had reached its greatest extension westwards, crossing parts of the 1°E. meridian. This spread of water from the east corresponds to the low phosphate conditions at the surface. The greatest enrichment of phosphate in the surface layers east of Shetland<sup>1</sup> was associated with the breakdown of the thermal stratification.

R. B. BURNS

### Monthly Anomalies of the Surface Temperature in an Area off the Eastern Coast of Scotland in 1956

(Figure 11; Table 3)

Table 3 gives for each month of 1956 the anomaly of the surface temperature in the Area F (56°–60°N., 0°–3°W., see Figure 11); the grand monthly means for 1°-squares for the period 1876–1915 were used as standards.

It appears from Table 3 that there is still a predominance of positive anomalies. However, averaged for the year the anomaly is 0.1°C. only, whereas it was 0.5°C. for the two foregoing years, and 1.0°C. in 1953.

JENS SMED

Table 3. Monthly anomalies ( $\Delta^{\circ}\text{C.}$ ) and numbers (n) of observations of the surface temperature in Area F in 1956 (see Figure 11)

| Jan.       | Feb.       | March      | April      | May        | June                | July       |
|------------|------------|------------|------------|------------|---------------------|------------|
| $\Delta$ n | $\Delta$ n | $\Delta$ n | $\Delta$ n | $\Delta$ n | $\Delta$ n          | $\Delta$ n |
| 0.0 62     | 0.1 35     | 0.1 44     | -0.2 30    | 0.4 61     | 0.2 66              | 0.1 62     |
| Aug.       | Sept.      | Oct.       | Nov.       | Dec.       | Average             |            |
| $\Delta$ n | $\Delta$ n | $\Delta$ n | $\Delta$ n | $\Delta$ n | of $\Delta$ -values |            |
| -0.2 73    | 0.1 108    | 0.4 61     | 0.2 67     | 0.5 47     | 0.1                 |            |

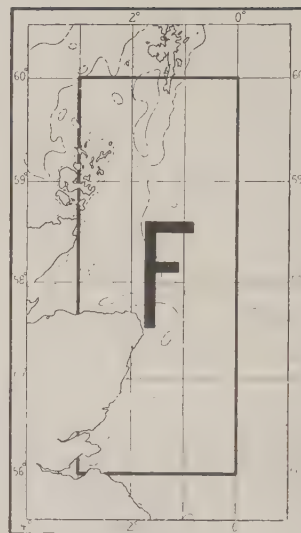


Figure 11. Location of area.

### Hydrographic Surveys of the Northern North Sea

(Figures 12–15)

Three surveys are reproduced for 1956. General comment is as follows:—

#### 1. Temperature

Temperatures were low throughout the year both at surface and at the bottom. In fact, for the part of the year covered by these surveys, temperatures generally are probably the lowest since the war.

#### 2. Salinity

This is expressed as D.C.I. (CRAIG, 1954<sup>1</sup>). The distribution shows a general similarity to 1955 with one noteworthy difference. As in 1955, there is no indication of the normal oceanic influx being particularly strong. However, conditions north and west of Orkney were markedly different from that year. Presumably on account of the very severe and prolonged drought in 1955, the accumulation of coastal water in that region was quite unusually slight. The result is that the inflow to the North Sea via the north of Orkney, which seems to have been most marked in June, was of more saline water than is usual.

Thus in July salinities are above normal east of the Moray Firth, while they are only about normal east of Shetland.

<sup>1</sup>) Ann. Biol., X, pp. 86–89.

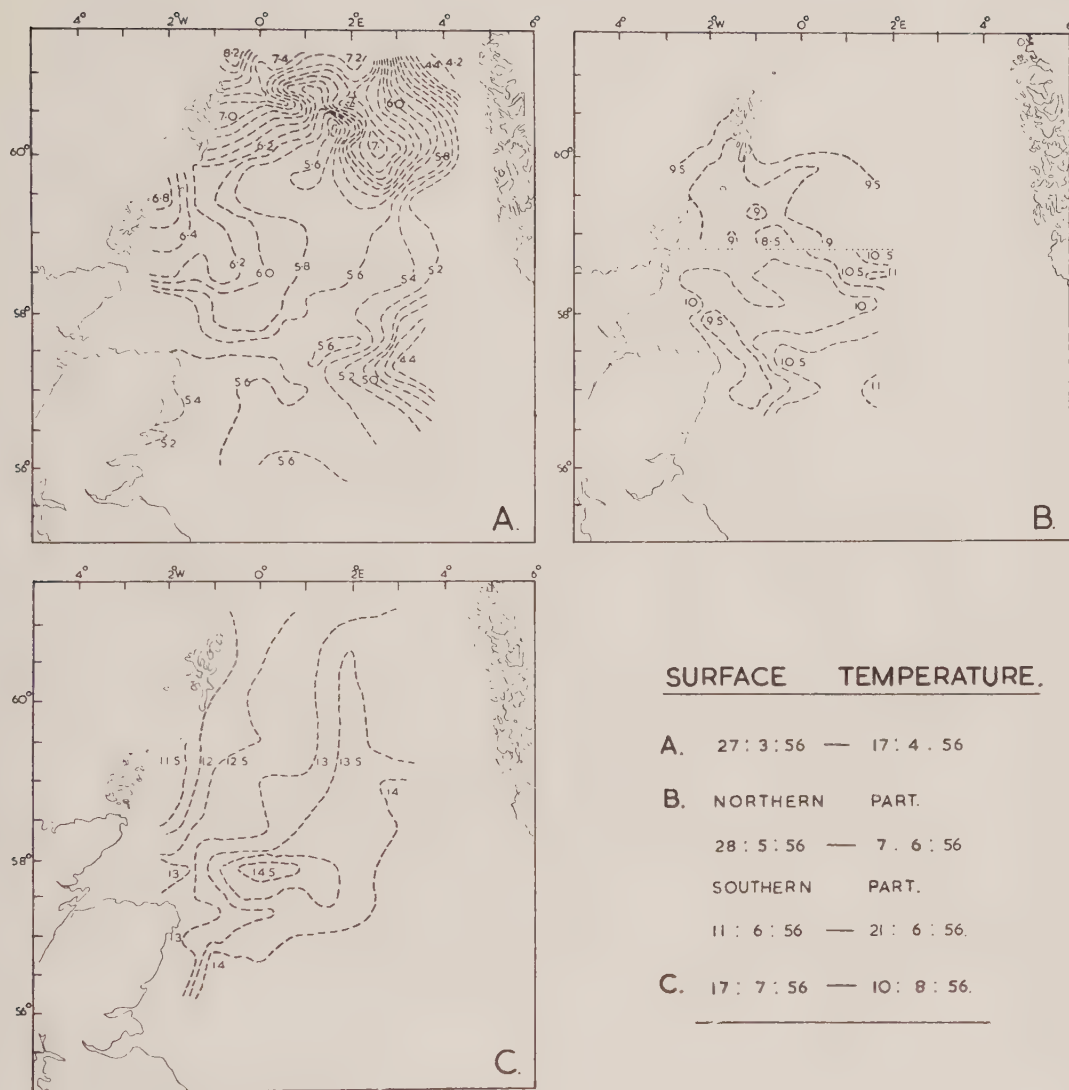


Figure 12. Surface temperatures, northern North Sea 1956.

### 3. General interpretation for 1956

- (a) Oceanic influence rather slight.
- (b) A marked deficiency of diluting effluent from the land.
- (c) Temperatures generally low with a less marked thermocline than usual.

R. E. CRAIG

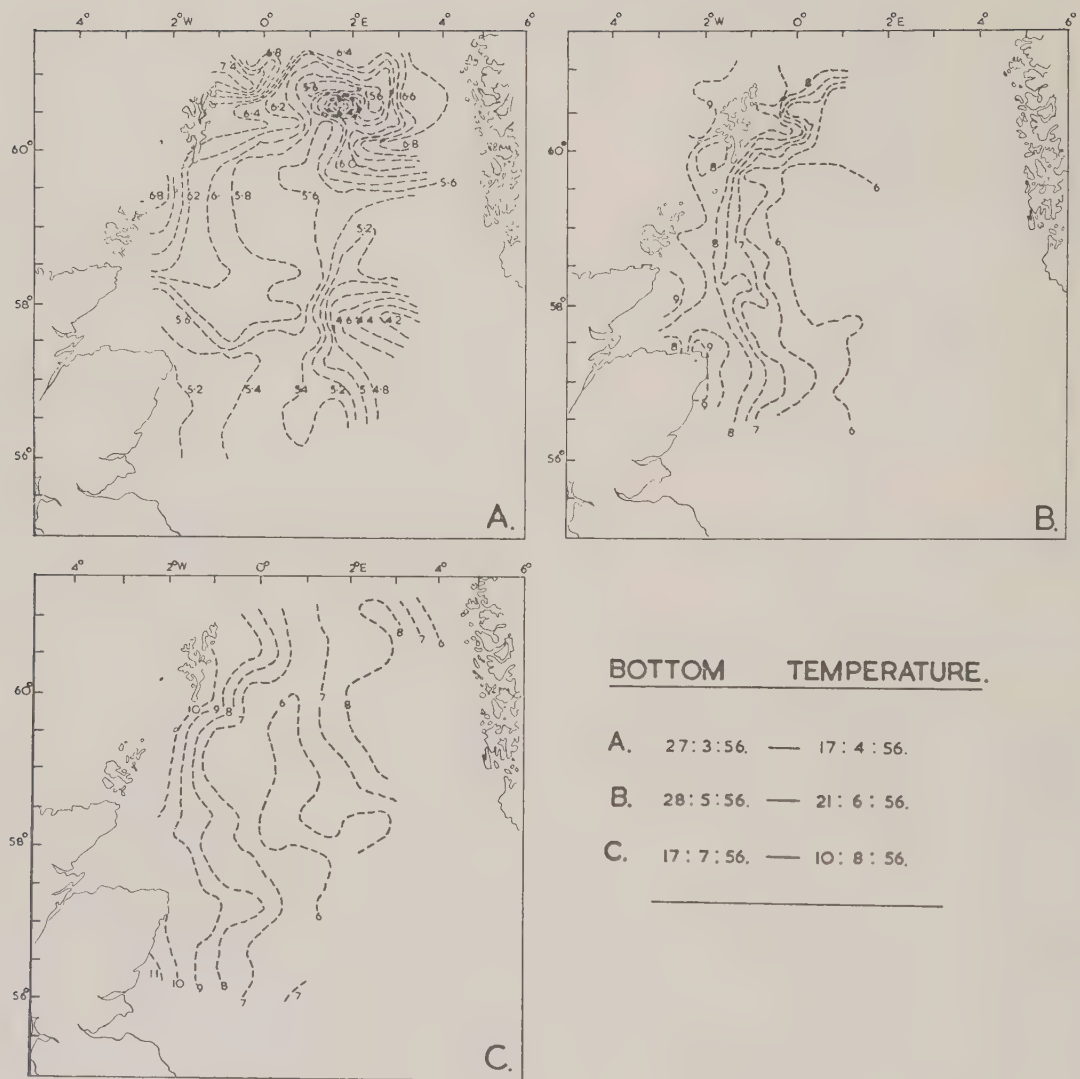


Figure 13. Bottom temperatures, northern North Sea 1956



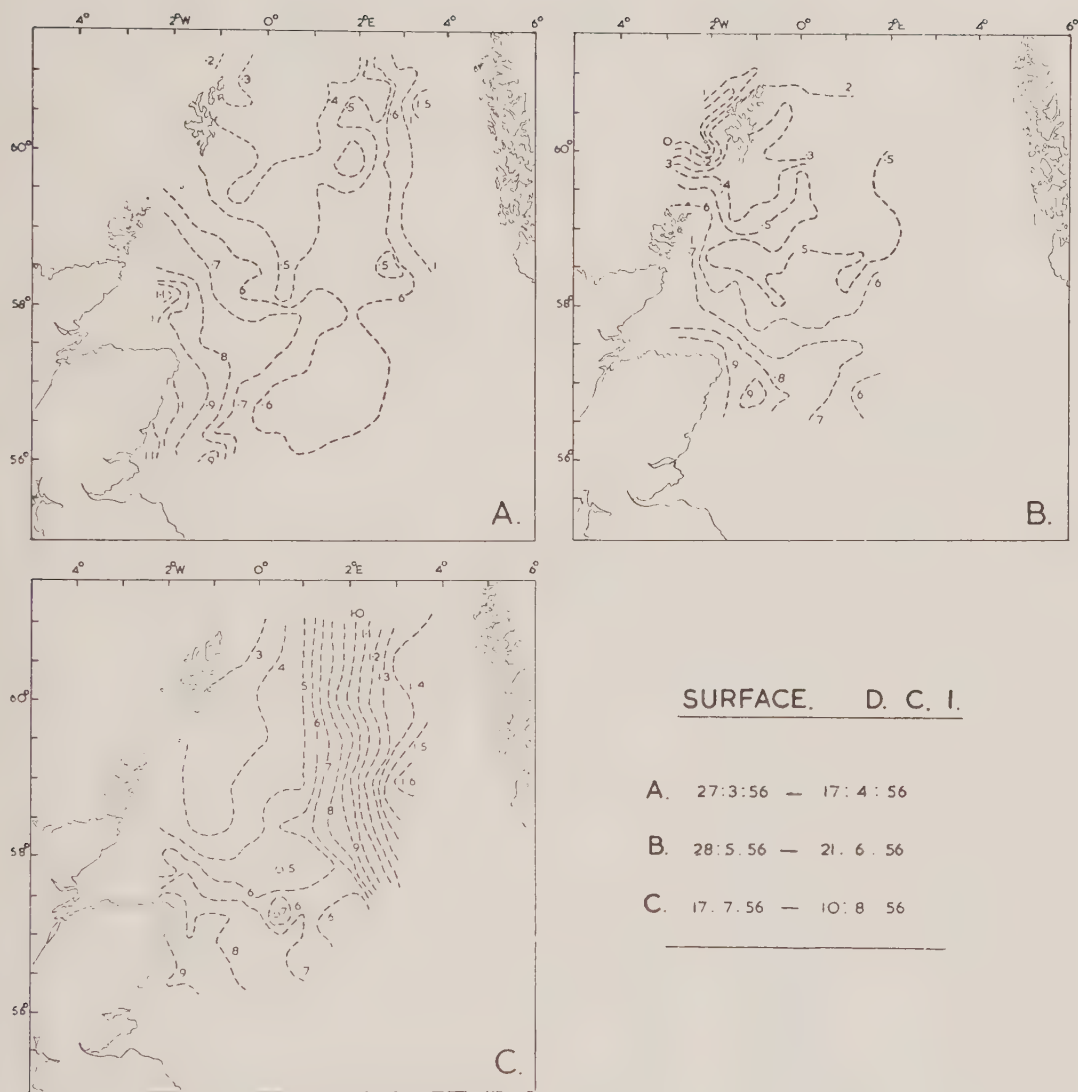


Figure 14. Surface D.C.I., northern North Sea 1956.

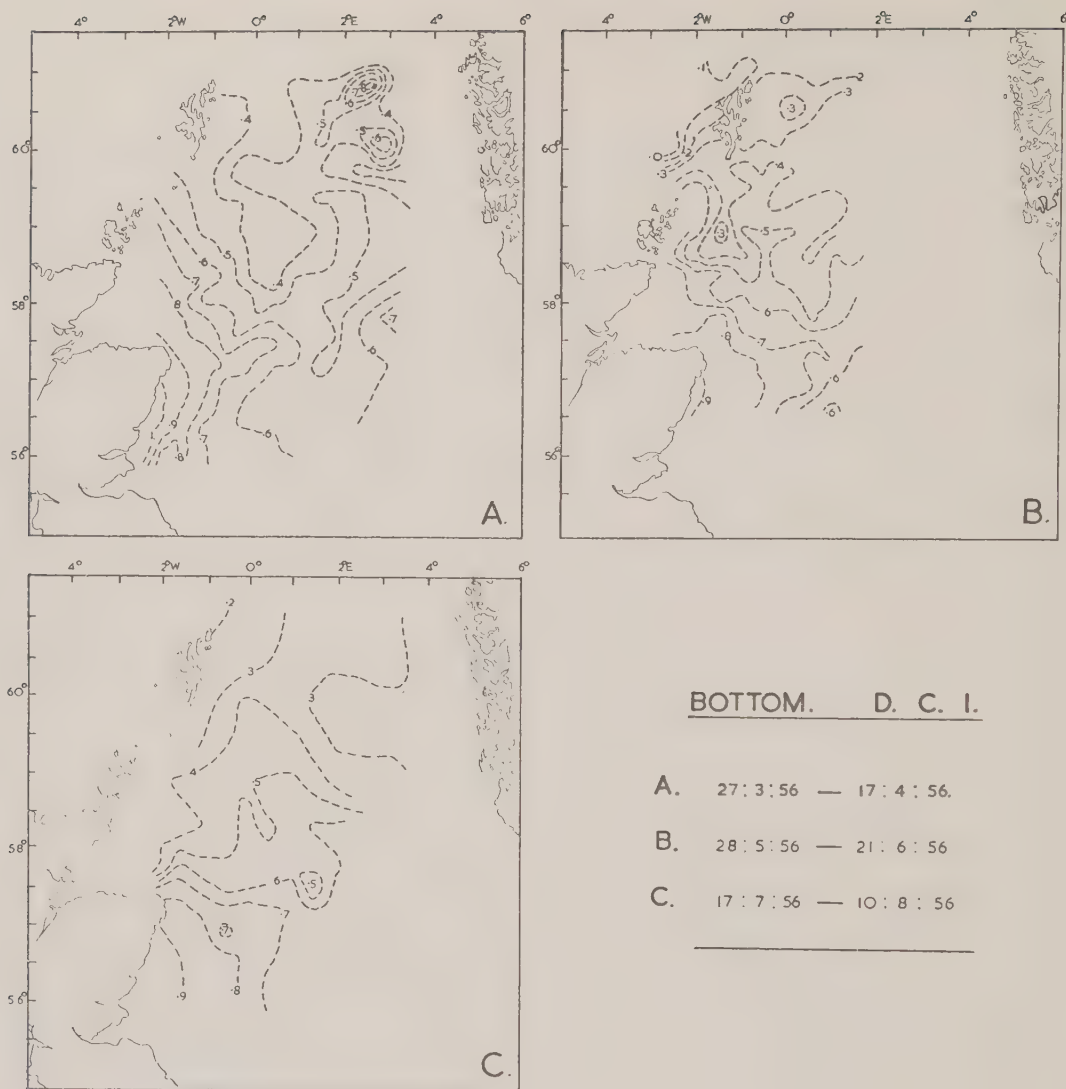


Figure 15. Bottom D.C.I., northern North Sea 1956.

### Hydrographic Conditions in the Northern North Sea and in the Norwegian Rinne, February 1956

(Figures 16-19)

Hydrographic observations were made by the "Anton Dohrn" at 97 stations in the northern North Sea and Norwegian Rinne between 16. February and 7. March 1956. Figures 16 and 17 show the distributions of temperature and salinity at

the bottom. Figure 18 shows the temperature and salinity in a north-south section across the Norwegian Rinne off Lindesnes; and Figure 19 is a west-east profile from the Shetlands to Bergen (Norway). The warm Atlantic water enters the North Sea in two branches, the strongest influx apparently taking place along the western slope of the Norwegian Rinne.

W. KRAUSS

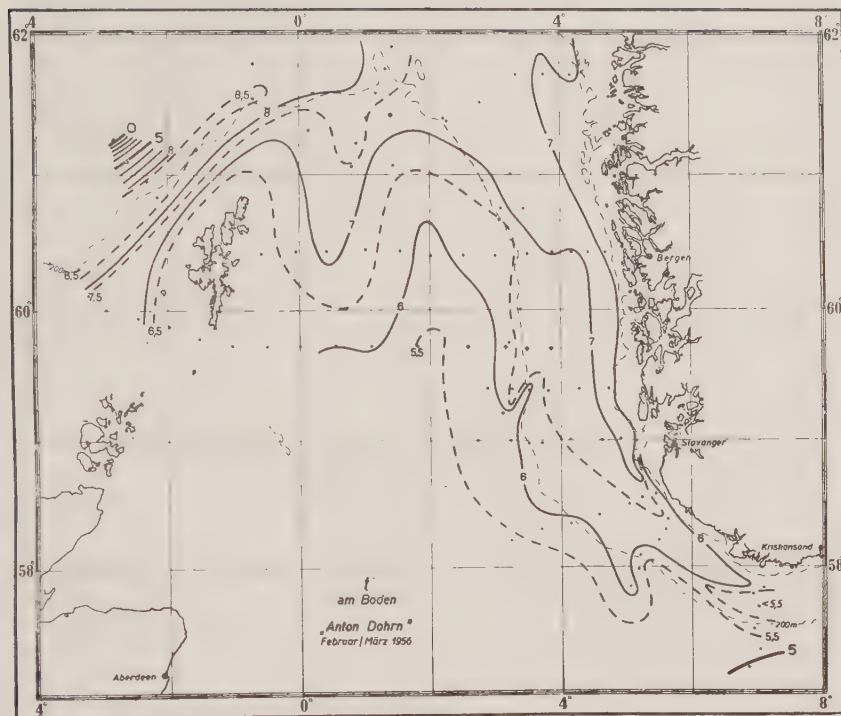


Figure 16. Distribution of temperature at the bottom of the northern North Sea between 16. February and 7. March 1956.

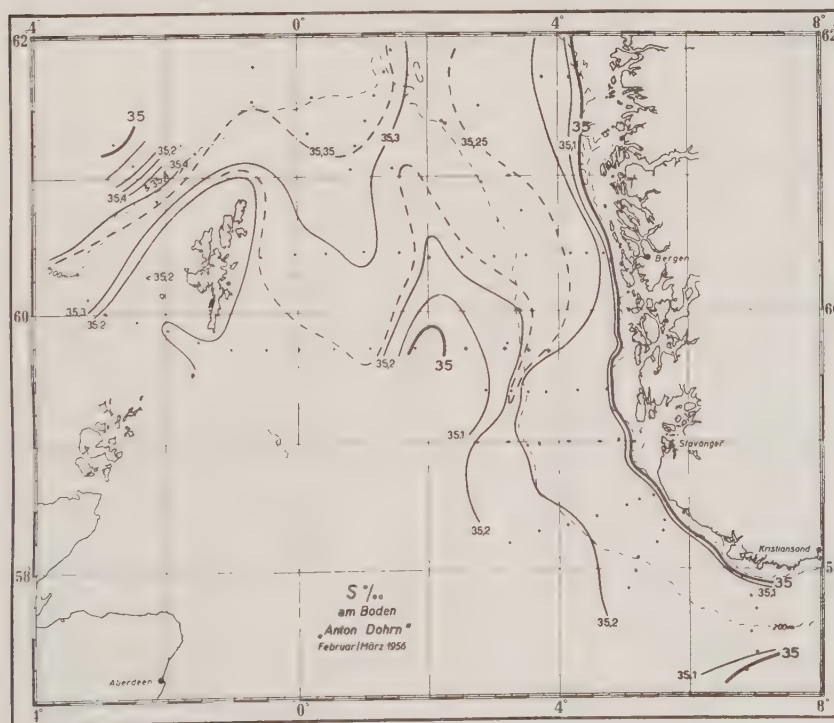


Figure 17. Distribution of salinity at the bottom of the northern North Sea between 16. February and 7. March 1956.

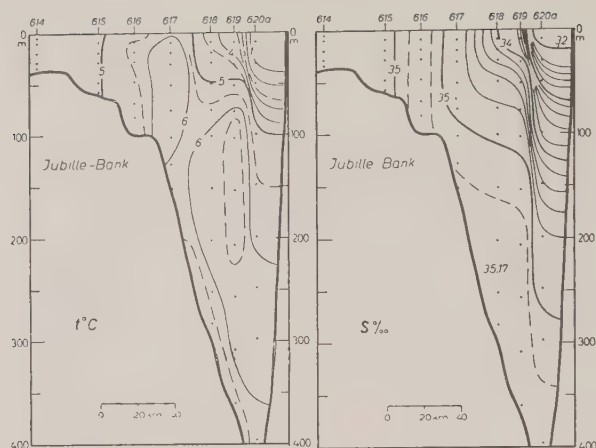


Figure 18. Distribution of temperature and salinity in a vertical section across the Norwegian Rinne off Lindesnes on 18. February 1956.

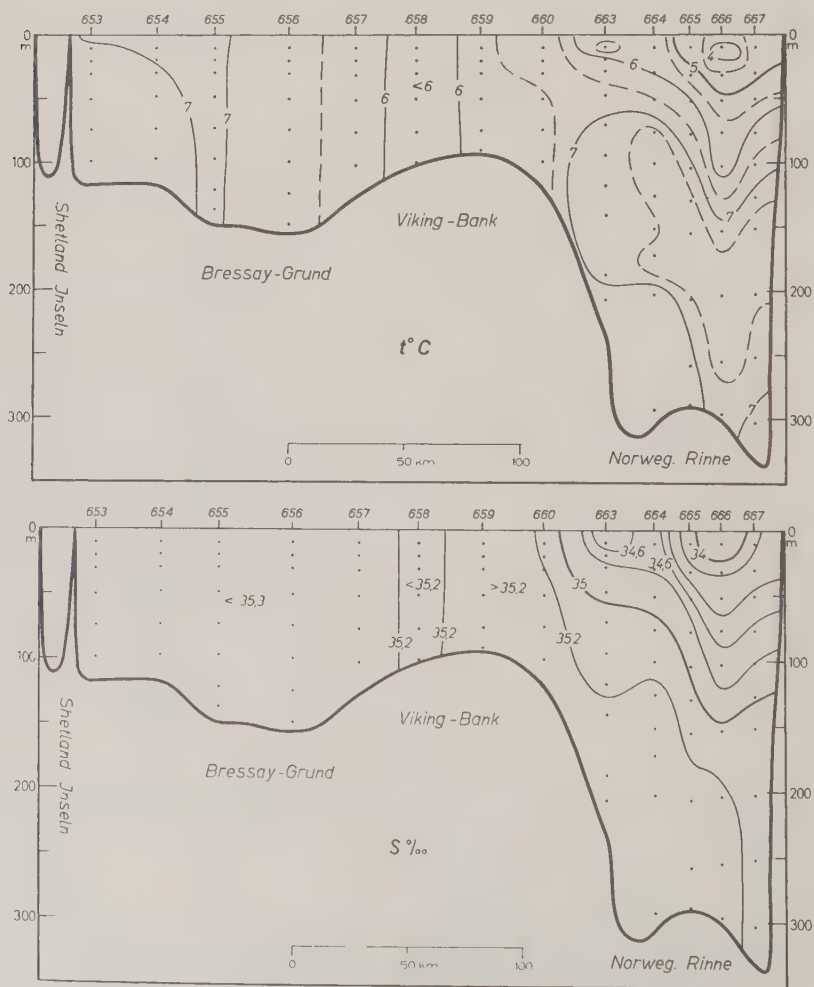


Figure 19. Distribution of temperature and salinity in the west-east section from the Shetlands to Norway from 23. to 25. February 1956.



**Hydrographic Conditions in the North Sea 1956**

(Figures 20–35)

Three Danish ships worked in the North Sea in 1956. The M/C "Sujumut" took observations in April, May, and June, the M/C "Jens Væver" in June and July, and the R/V "Dana" in August and September. Figures 20–25 show the distribution of temperature and salinity in the three periods.

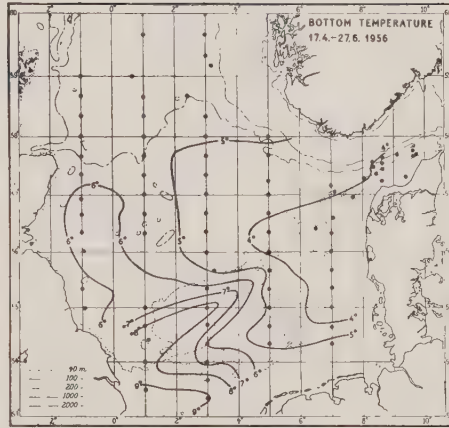
Bottom temperature on the Bløden Ground area was very low in spring and early summer.

In the autumn very little cold bottom water was found in the Bløden Ground region compared with previous years. The mixing of the water masses appears to have taken place about one month earlier than usual.

Figures 26–35 show some of the sections worked in the three periods. Section R and the section along 5°E. in August demonstrate clearly that only very little cold bottom water remained at the end of August.

The sections along 1°E. and 3°E. seem to indicate that a large outflow from the Baltic took place in autumn. These sections also show the strong development of stratification in the water masses north of the Dogger Bank. The thickness of the discontinuity layer in the autumn was probably often much less than the diagrams show. A bathythermograph record from "Dana" station No. 173 shows a thickness of less than 1 metre.

K. P. ANDERSEN



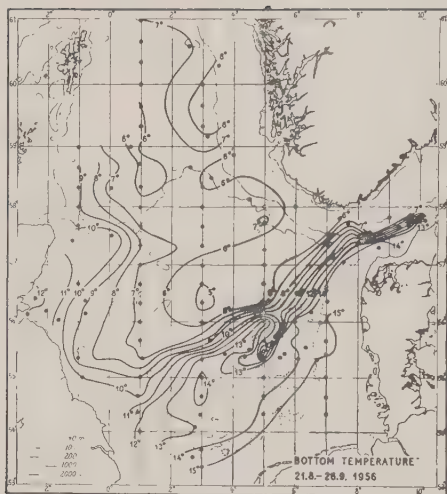


Figure 24. Bottom temperature, August—September 1956.

Figure 25. Bottom salinity, August—September 1956.

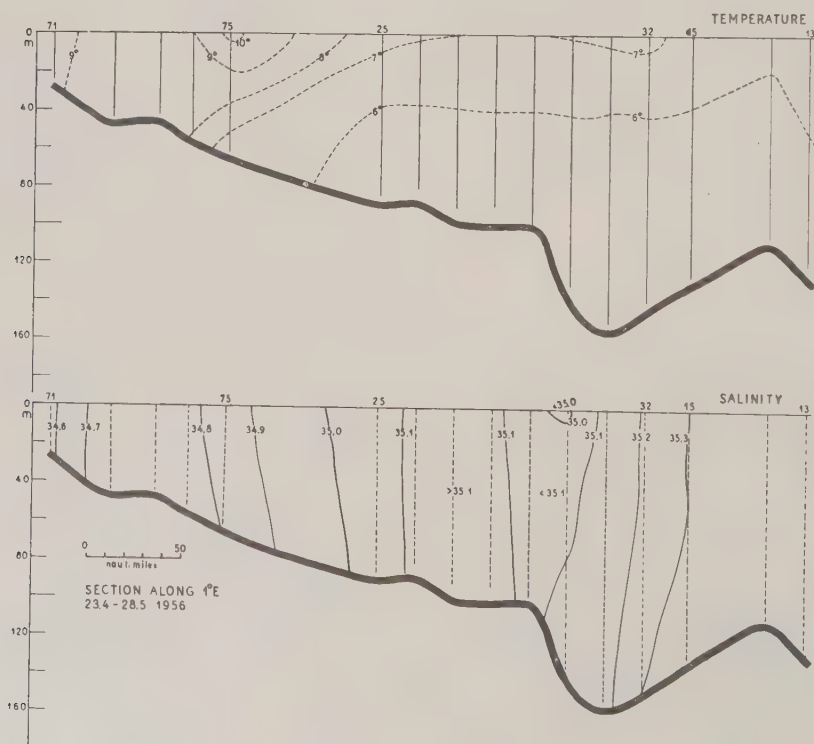


Figure 26. Section along 1°E., temperature and salinity, April—May 1956.

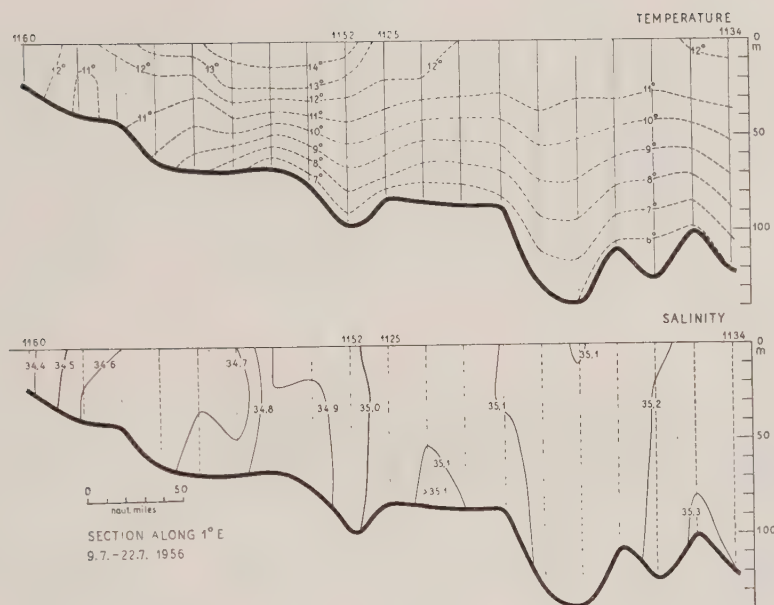


Figure 27. Section along 1°E., temperature and salinity,  
July 1956.

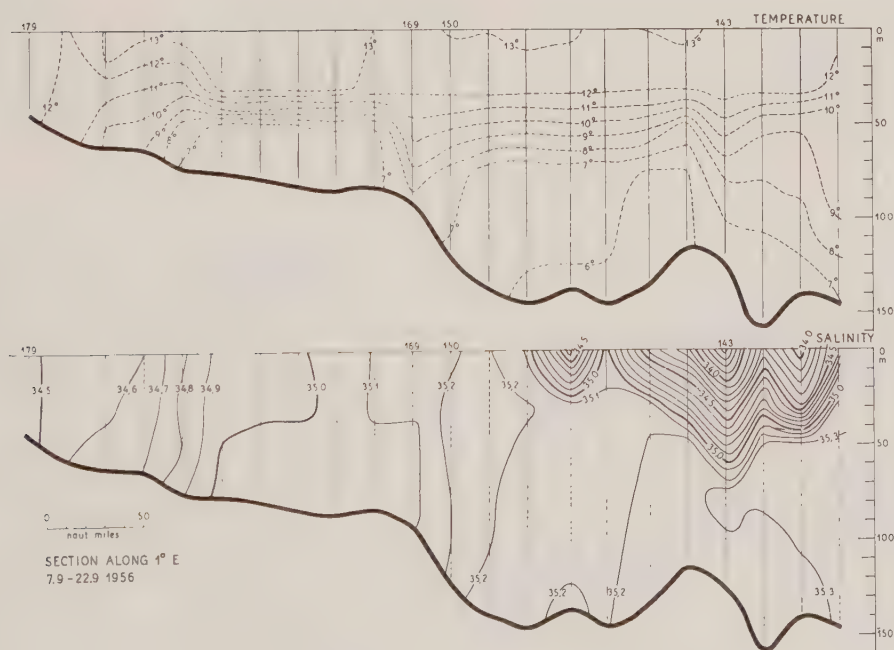


Figure 28. Section along 1°E., temperature and salinity,  
September 1956.

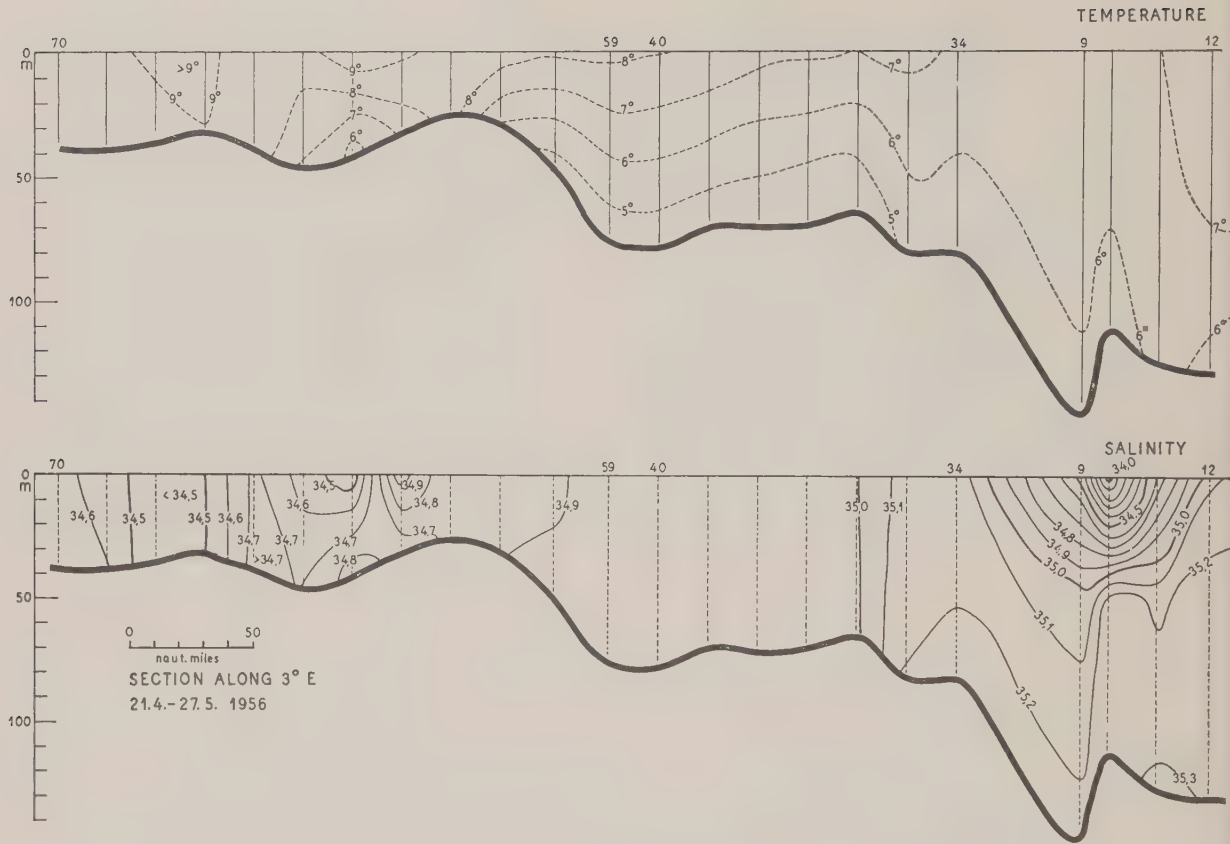


Figure 29. Section along 3°E., temperature and salinity, April–May 1956.

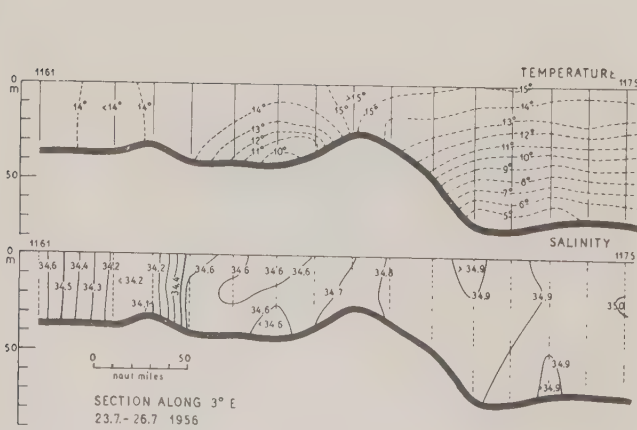


Figure 30. Section along 3°E., temperature and salinity, July 1956.

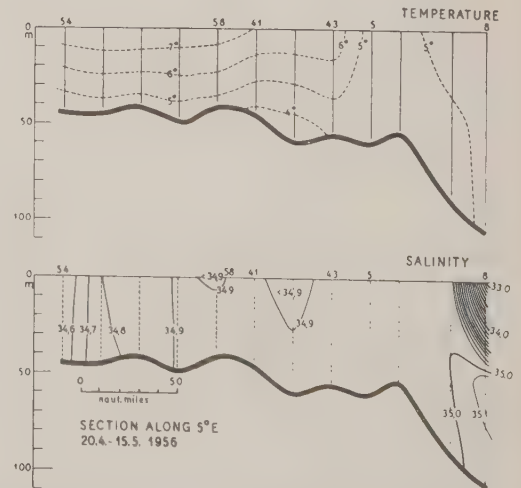


Figure 32. Section along 5°E., temperature and salinity, April–May 1956.



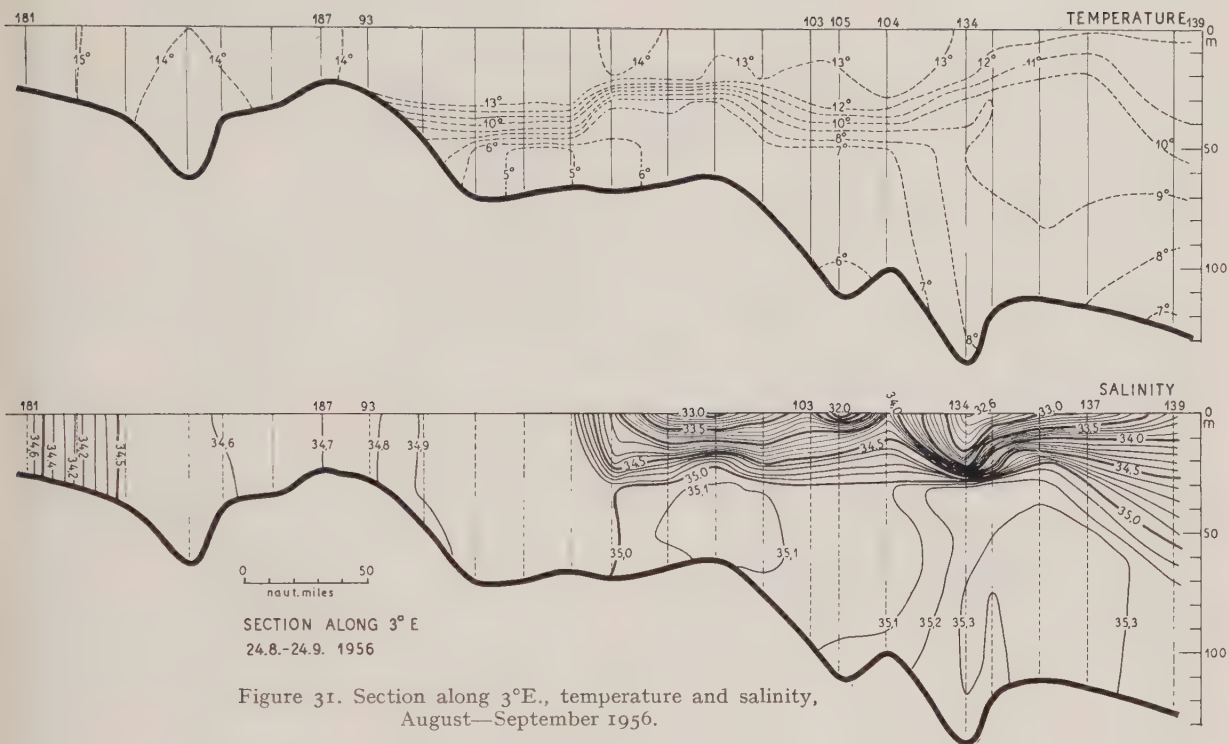


Figure 31. Section along 3°E., temperature and salinity, August–September 1956.



Figure 33. Section along 5°E., temperature and salinity, June 1956.

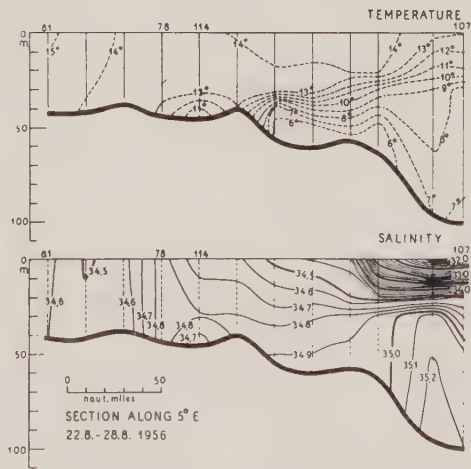


Figure 34. Section along 5°E., temperature and salinity, August 1956.

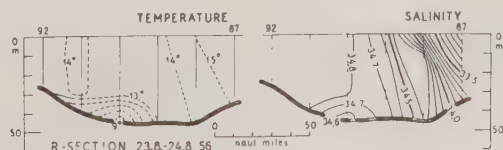
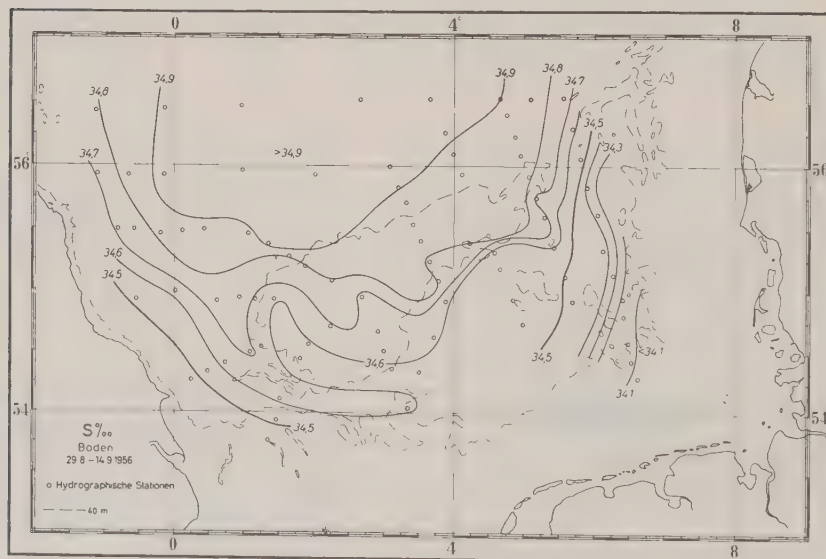
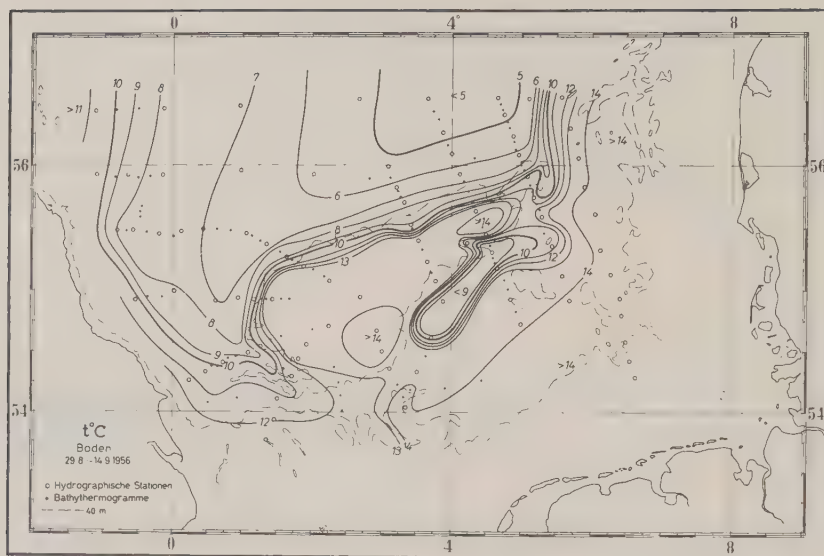


Figure 35. International section R, temperature and salinity, August 1956.



Figures 36 and 37. Bottom temperature and salinity in the Dogger Bank region in September 1956.

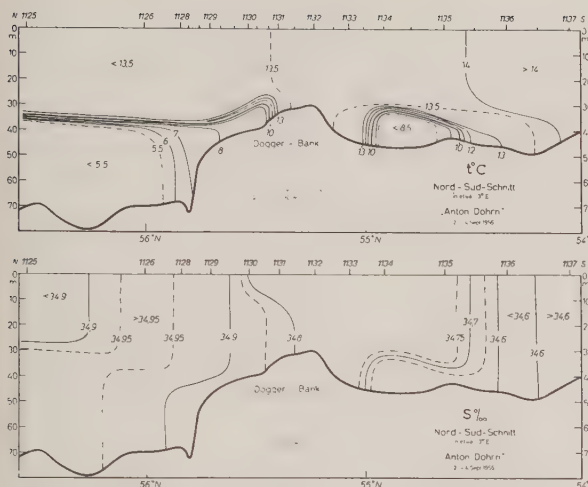
### Hydrographic Conditions in the Dogger Bank Region in September 1956

(Figures 36-39)

From 29. August to 14. September 1956 the research ship "Anton Dohrn" carried out a cruise in the Dogger Bank region on which 85 hydro-

graphical stations were occupied and 88 bathythermograms taken. The positions are shown in Figure 36.

Figures 36 and 37 show the distributions of temperature and salinity near the bottom. Figures 38 and 39 show an example of layering on one of the sections across the bank. They are based on



Figures 38 and 39. Temperature and salinity on a north-south section across the Dogger Bank in about 3°E., from observations made on 2.—4. September 1956.

observations made between 2. and 4. September on a line running nearly north-south between 3° and 4°E. Two typical regions may be distinguished with regard to depth and tidal streams:—

(1) The shallower part of the Dogger Bank and the German Bight beyond the coastal areas are covered with homogeneous water masses; either the water is too shallow or the mixing by the tidal streams is too strong for a discontinuity layer to exist.

(2) Regions with stratified water both northward and southward of the bank, with a very sharp thermocline.

There are two masses of cold bottom water; the northern mass, with temperatures below 5°C., is unusually cold, compared with previous years (G. PRAHM, p. 76). The cold bottom water south-east of the Dogger Bank seems to be an isolated mass with temperatures below 9°C., a residue from the winter but unlike the northern mass it is heated during spring, because mixing by tidal streams renders the formation of a thermocline more difficult. This isolated cold water mass south-east of the bank is a typical feature of the lower layer in summer. Its extent and its minimum temperature may be expected to change from year to year and may influence the fisheries.

G. DIETRICH

Table 4. Monthly means of temperature and salinity at surface and bottom, for 1950/54 and 1956, at the German Light-vessels "Borkumriff", "P 8", "P 12", "Elbe 1", and "Weser"  
(From Deutsches Hydrographisches Institut, Hamburg)

| Month               |              | I     | II    | III   | IV    | V     | VI    | VII   | VIII  | IX    | X     | XI    | XII   |
|---------------------|--------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| <b>Temperature</b>  |              |       |       |       |       |       |       |       |       |       |       |       |       |
| <b>"Borkumriff"</b> | 1956         | 5.5   | 1.2   | 1.3   | 4.4   | 8.3   | 12.6  | 15.2  | 15.6  | 15.2  | 13.8  | 9.6   | 6.8   |
|                     | 1956         | 5.8   | 1.9   | 1.4   | 4.6   | 8.2   | 12.5  | 15.4  | 15.9  | 15.4  | 13.9  | 9.8   | 7.1   |
| <b>"P 8"</b>        | Mean 1950/54 | 5.6   | 3.6   | 3.7   | 5.4   | 9.4   | 13.2  | 15.5  | 16.8  | 16.3  | 13.6  | 10.7  | 7.5   |
|                     | 1956         | 5.0   | 1.6   | 1.2   | 3.9   | 8.9   | 12.2  | 14.9  | 15.2  | 15.0  | 13.8  | 10.3  | 7.3   |
| <b>"P 12"</b>       | Mean 1950/54 | 4.9   | 3.1   | 3.5   | 5.6   | 10.1  | 13.5  | 15.9  | 17.1  | 16.1  | 13.1  | 10.4  | 7.2   |
|                     | 1956         | 5.0   | 1.2   | 1.2   | 3.8   | 8.9   | 12.5  | 15.1  | 15.3  | 14.8  | 13.3  | 9.8   | —     |
| <b>"Elbe 1"</b>     | Mean 1950/54 | 3.9   | 2.4   | 3.3   | 5.8   | 9.3   | 13.2  | 16.3  | 17.3  | 16.0  | 12.8  | 9.7   | 6.2   |
|                     | 1956         | 4.4   | 0.4   | 1.3   | 4.2   | 9.1   | 12.7  | 14.9  | 15.5  | 15.1  | 12.9  | 9.0   | 6.3   |
| <b>"Weser"</b>      | Mean 1950/54 | 3.9   | 2.5   | 3.1   | 5.9   | 9.2   | 13.0  | 16.0  | 17.2  | 16.9  | 12.8  | 9.6   | 6.3   |
|                     | 1956         | 4.4   | 1.0   | 0.9   | 3.7   | 8.3   | 12.4  | 14.6  | 15.6  | 15.1  | 13.2  | 9.0   | 6.2   |
| <b>Salinity</b>     |              |       |       |       |       |       |       |       |       |       |       |       |       |
| <b>"Borkumriff"</b> | 1956         | 32.74 | 32.10 | 32.32 | 32.09 | 32.24 | 32.27 | 32.12 | 32.10 | 32.32 | 33.02 | 32.48 | 32.16 |
|                     | 1956         | 33.10 | 32.30 | 32.44 | 32.18 | 32.36 | 32.28 | 32.19 | 32.10 | 32.66 | 32.98 | 32.45 | 32.48 |
| <b>"P 8"</b>        | Mean 1950/54 | 33.82 | 33.77 | 33.40 | 33.59 | 33.04 | 32.98 | 33.36 | 33.18 | 33.04 | 33.65 | 33.91 | 33.76 |
|                     | 1956         | 32.95 | 33.08 | 33.14 | 31.76 | 31.59 | 31.86 | 31.68 | 32.37 | 33.10 | 33.33 | 33.21 | 33.23 |
| <b>"P 12"</b>       | Mean 1950/54 | 32.77 | 32.47 | 32.35 | 32.19 | 31.89 | 32.08 | 32.15 | 32.29 | 32.05 | 32.36 | 33.04 | 32.84 |
|                     | 1956         | 31.68 | 31.29 | 31.81 | 30.05 | 30.40 | 30.23 | 31.52 | 30.52 | 30.78 | 31.80 | 31.64 | —     |
| <b>"Elbe 1"</b>     | Mean 1950/54 | 31.71 | 33.36 | 32.95 | 31.15 | 31.38 | 31.80 | 31.65 | 32.01 | 31.53 | 31.57 | 32.28 | 32.03 |
|                     | 1956         | 30.48 | 30.76 | 30.57 | 29.22 | 29.74 | 29.75 | 29.66 | 29.66 | 29.75 | 30.24 | 30.47 | 30.75 |
| <b>"Weser"</b>      | Mean 1950/54 | 31.94 | 32.00 | 32.14 | 32.08 | 32.45 | 32.41 | 32.39 | 32.27 | 31.84 | 32.32 | 32.47 | 32.46 |
|                     | 1956         | 30.76 | 31.42 | 31.43 | 31.83 | 31.86 | 31.54 | 31.10 | 30.94 | 31.20 | 31.38 | 31.38 | 31.30 |

# Hydrographic Conditions of the German Bight in 1956

(Table 4)

In 1956 daily surface observations of temperature and salinity have been carried out (at 8<sup>h</sup> MET) at 5 German lightships, viz., "Borkumriff" (53°45'N., 6°24.2'E.); "P 8" (54°16'N., 7°11.5'E.); "P 12" (54°00'N., 7°51.5'E.); "Elbe 1" (54°00'N., 8°10.7'E.), and "Weser" (53°51.6'N., 7°53.2'E.). At the "Borkumriff" lightship subsurface hydrographical observations were also carried out at various depths once a week. The observations are representative of the estuarine and coastal waters in the German Bight. The observations will be published in full by the Deutsches Hydrographisches Institut, Hamburg, under the title of "Beobachtungen auf den deutschen Feuerschiffen der Nord- und Ostsee im Jahre 1956", Meeresk. Beobacht. u. Ergebn., 9. In addition, monthly means are given here in Table 4.

The surface temperature in 1956 was about normal in January and from October to December, and relatively low from February to September, compared with the monthly means for 1950/54. The annual means for 1956 are accordingly about 1°C. lower than those for the period 1950/54:—

|        | 1950/54 | 1956   |          | 1950/54 | 1956   |
|--------|---------|--------|----------|---------|--------|
| "P 8"  | 10.1°C. | 9.1°C. | "Elbe 1" | 9.7°C.  | 8.8°C. |
| "P 12" | 10.0°C. | 9.2°C. | "Weser"  | 9.7°C.  | 8.7°C. |

Surface salinity in 1956 was relatively low in every month, compared with the monthly mean values for the period 1950/54, and at every lightship the yearly means for 1956 are below those for the period 1950/54:—

|        | 1950/54                            | 1956                               |          | 1950/54                            | 1956                               |
|--------|------------------------------------|------------------------------------|----------|------------------------------------|------------------------------------|
| "P 8"  | 33.46 <sup>0</sup> / <sub>00</sub> | 32.61 <sup>0</sup> / <sub>00</sub> | "Elbe 1" | 31.95 <sup>0</sup> / <sub>00</sub> | 30.09 <sup>0</sup> / <sub>00</sub> |
| "P 12" | 32.37 <sup>0</sup> / <sub>00</sub> | 31.07 <sup>0</sup> / <sub>00</sub> | "Weser"  | 32.23 <sup>0</sup> / <sub>00</sub> | 31.35 <sup>0</sup> / <sub>00</sub> |

G. PRAHM

Table 5. Mean values of surface temperature at fixed positions on the Hamburg-Hull route

| Month                            | I                              | II  | III | IV  | V     | VI   | VII  | VIII | IX   | X    | XI     | XII    |
|----------------------------------|--------------------------------|-----|-----|-----|-------|------|------|------|------|------|--------|--------|
| Year                             | Position I: 54°09'N., 07°32'E. |     |     |     |       |      |      |      |      |      |        |        |
| 1953                             | —                              | —   | —   | —   | —     | —    | —    | —    | 16.4 | 14.4 | 12.6   | (9.8)  |
| 1954                             | —                              | 2.8 | 2.6 | 4.7 | 7.9   | 13.2 | 14.5 | 16.2 | 15.4 | 13.9 | (12.2) | (3.5)  |
| 1955                             | —                              | 3.3 | 2.8 | 4.9 | 8.4   | 12.7 | 17.0 | 18.5 | 17.5 | 14.0 | 11.2   | 8.8    |
| 1956                             | 5.9                            | 2.7 | 2.3 | 4.7 | 9.9   | 12.7 | 14.9 | 15.6 | 14.9 | 13.8 | 10.4   | 7.3    |
| Position II: 54°18'N., 06°12'E.  |                                |     |     |     |       |      |      |      |      |      |        |        |
| 1953                             | —                              | —   | —   | —   | —     | —    | —    | —    | 16.1 | 14.8 | 12.6   | 10.3   |
| 1954                             | —                              | 3.2 | 4.2 | 5.4 | 8.3   | 12.6 | 14.6 | 15.4 | 15.5 | 13.7 | 11.2   | —      |
| 1955                             | 5.9                            | 4.3 | 2.9 | 4.7 | 7.4   | 12.0 | 16.4 | 18.1 | 16.9 | 14.7 | 11.6   | 9.1    |
| 1956                             | 6.4                            | 3.3 | 3.4 | 4.5 | (7.7) | 11.9 | 14.7 | 15.0 | 14.9 | 13.8 | 10.6   | 8.2    |
| Position III: 54°19'N., 05°21'E. |                                |     |     |     |       |      |      |      |      |      |        |        |
| 1953                             | —                              | —   | —   | —   | —     | —    | —    | —    | 16.2 | 14.8 | 12.6   | 10.1   |
| 1954                             | —                              | 3.9 | 4.4 | 5.6 | 9.2   | 12.9 | 14.1 | 15.4 | 14.7 | 13.7 | 10.6   | —      |
| 1955                             | 6.1                            | 4.8 | 3.8 | 4.8 | 7.5   | 12.7 | 16.2 | 18.0 | 16.8 | 14.3 | 11.4   | 9.8    |
| 1956                             | 6.3                            | 3.4 | 3.4 | 5.3 | (8.3) | 12.0 | 14.9 | 14.9 | 14.4 | 13.6 | 10.9   | (7.5)  |
| Position IV: 54°10'N., 04°26'E.  |                                |     |     |     |       |      |      |      |      |      |        |        |
| 1953                             | —                              | —   | —   | —   | —     | —    | —    | —    | 16.1 | 14.7 | 12.4   | (11.3) |
| 1954                             | —                              | 4.2 | 4.8 | 5.5 | 8.9   | 12.7 | 14.2 | 15.0 | 14.7 | 13.5 | 10.8   | (8.4)  |
| 1955                             | 6.4                            | 5.0 | 4.8 | 5.6 | 7.8   | 12.8 | 16.3 | 18.0 | 16.9 | 13.7 | 11.6   | 9.5    |
| 1956                             | (5.9)                          | 4.3 | 4.1 | 5.5 | (9.2) | 12.1 | 14.9 | 14.1 | 14.7 | 13.4 | 11.3   | 8.2    |
| Position V: 54°00'N., 03°32'E.   |                                |     |     |     |       |      |      |      |      |      |        |        |
| 1953                             | —                              | —   | —   | —   | —     | —    | —    | —    | —    | —    | 11.9   | (10.9) |
| 1954                             | —                              | 4.9 | 5.2 | —   | —     | 12.3 | 13.6 | 14.9 | 14.2 | 13.1 | 10.7   | (8.1)  |
| 1955                             | 6.1                            | 4.9 | 4.1 | 6.3 | 7.7   | 12.0 | 16.2 | 17.8 | 16.2 | 13.7 | 11.5   | 9.8    |
| 1956                             | 6.6                            | 3.6 | 4.4 | 5.9 | (8.8) | 12.2 | 14.7 | 14.2 | 14.5 | 13.4 | 10.9   | 8.6    |
| Position VI: 53°53'N., 02°43'E.  |                                |     |     |     |       |      |      |      |      |      |        |        |
| 1953                             | —                              | —   | —   | —   | —     | —    | —    | —    | 15.0 | 14.5 | 12.3   | (10.9) |
| 1954                             | —                              | 4.5 | 5.3 | 6.8 | 8.9   | 11.5 | 13.3 | 14.3 | 13.7 | 13.2 | 10.7   | 8.3    |
| 1955                             | 6.8                            | 4.9 | 3.9 | 6.1 | 7.9   | 11.1 | 14.9 | 16.6 | 15.7 | 12.5 | 11.9   | 9.9    |
| 1956                             | 6.6                            | 4.1 | 4.7 | 5.6 | (8.4) | 11.3 | 14.4 | 13.6 | 14.0 | 12.9 | 10.9   | 8.5    |
| Position VII: 53°45'N., 01°54'E. |                                |     |     |     |       |      |      |      |      |      |        |        |
| 1953                             | —                              | —   | —   | —   | —     | —    | —    | —    | 14.7 | 14.0 | 11.5   | (9.8)  |
| 1954                             | —                              | 4.4 | 5.4 | 6.8 | 9.3   | 11.3 | 12.7 | 13.8 | 13.5 | 12.6 | 10.2   | —      |
| 1955                             | (6.5)                          | 4.8 | 3.8 | 5.8 | 7.6   | 11.4 | 13.5 | 15.8 | 15.2 | 12.6 | 11.2   | (9.7)  |
| 1956                             | 6.9                            | 4.3 | 5.2 | 6.2 | (9.6) | 11.1 | 13.8 | 13.3 | 13.5 | 12.2 | 10.5   | 8.1    |



**Means and Anomalies of Temperature and Salinity  
on the Hamburg-Hull Route in 1956**

(Tables 5-7)

Since September 1953 surface observations have been made on the Hamburg-Hull route by German commercial vessels on behalf of the German Hydrographic Institute. Routine observations are made from the moving ship at seven fixed positions; a water sample for later determination of salinity (Knudsen titration) is taken at the same time. The temperature and salinity observations collected over the period 1953-1956 have been summarized as far as possible as monthly means (see Tables 5 and 6). In addition, monthly anomalies referred to the period 1902 to 1928<sup>1)</sup>, have been computed for 1956. These departures from long-period means (see Table 7) provide an insight into the monthly variation of the heat and salt budgets in

the surface water of the southern North Sea, and may be of importance in connexion with fishery problems. The temperature anomalies show that the water at the surface of the southern North Sea was abnormally warm in January 1956 and also from October to December, whereas it was abnormally cold in nearly all other months. The cold and wet summer (August) is reflected in the lowness of the water temperature<sup>2)</sup>. Moreover, the excessively heavy rainfall in the coastal area, together with a strong outflow of coastal water into the German Bight, resulted in a considerable decrease in salinity during the summer months (cf. conditions in former years<sup>3)</sup>. The positive anomalies of temperature and salinity in January were responsible for the lateness of the ice formation off the German North Sea coasts<sup>4)</sup>. The

<sup>2)</sup> Deutscher Wetterdienst: (a) Monatliche Witterungsberichte, 4. Jahrg.; (b) Die Großwetterlagen Mitteleuropas, 9. Jahrg. Bad Kissingen, 1956.

<sup>3)</sup> Ber. Dtsch. Wiss. Komm. Meeresforsch., 14 (2): 109-46.

<sup>4)</sup> Der Seewart, 18 (1): 9-22; (2): 50-65.

**Table 6. Mean values of surface salinity at fixed positions on the Hamburg-Hull route**

| Month                            | I                              | II    | III   | IV    | V       | VI    | VII   | VIII  | IX    | X     | XI      | XII     |
|----------------------------------|--------------------------------|-------|-------|-------|---------|-------|-------|-------|-------|-------|---------|---------|
| Year                             | Position I: 54°09'N., 07°32'E. |       |       |       |         |       |       |       |       |       |         |         |
| 1953                             | —                              | —     | —     | —     | —       | —     | —     | —     | 31.86 | 32.50 | 33.27   | (33.71) |
| 1954                             | —                              | 33.98 | 33.68 | 32.70 | 33.68   | 33.74 | 33.60 | 33.22 | 32.92 | 34.19 | (34.00) | (32.77) |
| 1955                             | —                              | 33.35 | 33.22 | 31.86 | 32.13   | 31.93 | 31.03 | 31.90 | 32.62 | 33.31 | 32.81   | 32.56   |
| 1956                             | 32.71                          | 33.24 | 32.85 | 31.84 | 31.00   | 31.69 | 30.83 | 31.78 | 32.95 | 32.82 | 32.95   | 32.68   |
| Position II: 54°18'N., 06°12'E.  |                                |       |       |       |         |       |       |       |       |       |         |         |
| 1953                             | —                              | —     | —     | —     | —       | —     | —     | —     | 34.21 | 34.31 | 34.70   | 34.75   |
| 1954                             | —                              | 34.66 | 34.73 | 34.54 | 34.38   | 34.35 | 34.81 | 34.41 | 34.53 | 34.44 | 34.65   | —       |
| 1955                             | 34.93                          | 34.59 | 34.33 | 34.36 | 34.14   | 33.91 | 33.08 | 33.03 | 33.93 | 33.64 | 34.24   | 34.16   |
| 1956                             | 34.43                          | 34.41 | 34.14 | 34.03 | (33.75) | 33.21 | 33.34 | 33.90 | 34.23 | 34.31 | 34.43   | 34.42   |
| Position III: 54°19'N., 05°21'E. |                                |       |       |       |         |       |       |       |       |       |         |         |
| 1953                             | —                              | —     | —     | —     | —       | —     | —     | —     | 34.38 | 34.46 | 34.75   | 34.67   |
| 1954                             | —                              | 34.89 | 34.81 | 34.70 | 34.55   | 34.65 | 34.76 | 34.63 | 34.51 | 34.35 | 34.61   | —       |
| 1955                             | 34.75                          | 34.64 | 34.22 | 34.45 | 34.37   | 33.68 | 33.91 | 33.66 | 34.25 | 34.09 | 34.67   | 34.55   |
| 1956                             | 34.71                          | 34.78 | 34.36 | 34.10 | (34.33) | 33.89 | 33.62 | 34.40 | 34.49 | 34.43 | 34.50   | (34.54) |
| Position IV: 54°10'N., 04°26'E.  |                                |       |       |       |         |       |       |       |       |       |         |         |
| 1953                             | —                              | —     | —     | —     | —       | —     | —     | —     | 34.63 | 34.72 | 34.71   | (34.74) |
| 1954                             | —                              | 34.72 | 34.83 | 34.73 | 34.69   | 34.67 | 34.78 | 34.75 | 34.75 | 34.70 | 34.62   | (34.67) |
| 1955                             | 34.62                          | 34.70 | 34.49 | 34.57 | 34.54   | 34.32 | 34.26 | 34.29 | 34.48 | 34.30 | 34.91   | 34.80   |
| 1956                             | (34.80)                        | 34.83 | 34.78 | 34.45 | (34.41) | 34.45 | 34.41 | 34.58 | 34.61 | 34.60 | 34.63   | 34.58   |
| Position V: 54°00'N., 03°32'E.   |                                |       |       |       |         |       |       |       |       |       |         |         |
| 1953                             | —                              | —     | —     | —     | —       | —     | —     | —     | —     | —     | 34.80   | (34.77) |
| 1954                             | —                              | 34.83 | 34.88 | —     | —       | 34.72 | 34.83 | 34.77 | 34.71 | 34.64 | 34.73   | (34.64) |
| 1955                             | 34.75                          | 34.84 | 34.67 | 34.59 | 34.64   | 34.48 | 34.35 | 34.37 | 34.65 | 34.85 | 34.90   | 34.97   |
| 1956                             | 34.81                          | 34.78 | 34.76 | 34.69 | (34.61) | 34.56 | 34.54 | 34.64 | 34.66 | 34.60 | 34.69   | 34.65   |
| Position VI: 53°53'N., 02°43'E.  |                                |       |       |       |         |       |       |       |       |       |         |         |
| 1953                             | —                              | —     | —     | —     | —       | —     | —     | —     | 34.77 | 34.78 | 34.77   | (34.82) |
| 1954                             | —                              | 34.89 | 34.91 | 34.82 | 34.90   | 34.85 | 34.85 | 34.77 | 34.65 | 34.71 | 34.70   | (34.72) |
| 1955                             | 34.74                          | 34.83 | 34.54 | 34.69 | 34.78   | 34.73 | 34.55 | 34.54 | 34.77 | 34.84 | 34.88   | 34.84   |
| 1956                             | 34.79                          | 34.76 | 34.75 | 34.73 | (34.69) | 34.65 | 34.66 | 34.59 | 34.60 | 34.59 | 34.64   | 34.62   |
| Position VII: 53°45'N., 01°54'E. |                                |       |       |       |         |       |       |       |       |       |         |         |
| 1953                             | —                              | —     | —     | —     | —       | —     | —     | —     | 34.79 | 34.81 | 34.75   | (34.74) |
| 1954                             | —                              | 34.76 | 34.88 | 34.95 | 35.00   | 34.88 | 34.78 | 34.64 | 34.56 | 34.66 | 34.66   | —       |
| 1955                             | (34.79)                        | 34.90 | 34.62 | 34.73 | 34.70   | 34.70 | 34.74 | 34.69 | 34.73 | 34.83 | 34.74   | (34.69) |
| 1956                             | 34.68                          | 34.71 | 34.73 | 34.79 | (34.77) | 34.70 | 34.67 | 34.53 | 34.49 | 34.50 | 34.63   | 34.51   |

Table 7. Monthly anomalies of surface temperature and salinity for 1956 (referred to 1902—1928) on fixed positions on the Hamburg—Hull route

| Month<br>Pos. Nos. Anomaly | I       | II    | III       | IV    | V             | VI    | VII       | VIII  | IX    | X         | XI    | XII       |
|----------------------------|---------|-------|-----------|-------|---------------|-------|-----------|-------|-------|-----------|-------|-----------|
| I ..... $\Delta T$         | +1.7    | -0.7  | -1.9      | -1.5  | +0.2          | -0.5  | -0.9      | -1.1  | -0.6  | +0.7      | +0.7  | +0.6      |
| $\Delta S$                 | +0.71   | +0.84 | +0.85     | +0.84 | -1.20         | +0.69 | -1.57     | -0.72 | +0.45 | +0.22     | -0.15 | -0.32     |
| II ..... $\Delta T$        | +1.1    | -1.0  | -1.4      | -1.7  | (-1.6)        | -0.8  | -0.7      | -1.2  | -0.5  | +0.4      | +0.3  | +0.5      |
| $\Delta S$                 | -0.07   | -0.09 | -0.26     | -0.17 | (-0.25)       | -0.69 | -0.56     | -0.10 | +0.18 | -0.09     | +0.03 | -0.08     |
| III .... $\Delta T$        | +0.6    | -1.3  | -1.6      | -1.0  | (-0.9)        | -0.6  | -0.3      | -1.1  | -0.8  | +0.2      | +0.3  | (-0.7)    |
| $\Delta S$                 | +0.06   | +0.18 | -0.19     | -0.40 | (+0.03)       | -0.41 | -0.58     | +0.10 | +0.14 | -0.12     | -0.05 | (-0.01)   |
| IV ..... $\Delta T$        | (-0.1)  | -0.7  | -1.1      | -0.9  | ( $\pm 0.0$ ) | -0.3  | -0.2      | -1.8  | -0.4  | $\pm 0.0$ | +0.6  | $\pm 0.0$ |
| $\Delta S$                 | (+0.10) | +0.18 | +0.13     | -0.15 | (-0.14)       | -0.10 | +0.01     | +0.18 | +0.06 | -0.05     | -0.02 | -0.12     |
| V ..... $\Delta T$         | +0.5    | -1.5  | -0.9      | -0.6  | (-0.4)        | +0.2  | $\pm 0.0$ | -1.4  | -0.3  | +0.1      | +0.4  | +0.4      |
| $\Delta S$                 | +0.16   | +0.08 | +0.06     | -0.01 | (+0.11)       | +0.01 | -0.01     | +0.09 | -0.04 | -0.10     | +0.04 | -0.05     |
| VI ..... $\Delta T$        | +0.5    | -1.2  | -0.7      | -0.1  | (-0.6)        | -0.4  | +0.2      | -1.7  | -0.6  | -0.3      | +0.6  | +0.5      |
| $\Delta S$                 | +0.14   | +0.06 | $\pm 0.0$ | -0.02 | (+0.19)       | +0.15 | +0.01     | -0.06 | -0.10 | -0.06     | -0.01 | -0.08     |
| VII .... $\Delta T$        | +0.9    | -0.9  | -0.3      | -0.5  | (+0.8)        | -0.3  | +0.2      | -1.5  | -0.7  | -0.7      | +0.4  | +0.2      |
| $\Delta S$                 | +0.08   | +0.06 | -0.02     | +0.04 | (+0.12)       | +0.05 | +0.02     | -0.07 | -0.16 | -0.10     | +0.03 | -0.14     |

considerable negative anomalies of temperature and salinity in the western German Bight and in the central part of the southern North Sea can be interpreted as after-effects of the ice cover present over wide areas in the hard winter of 1955/56.

E. GOEDECKE

### Summer Bottom Temperature in two Selected Areas of the Central North Sea in the Years 1900—1956

(Figure 40)

Hydrographical investigations in the central North Sea have shown that extensive islands or tongues of cold bottom water with very uniform temperatures occur in summer each year at about the same place, the temperatures in different years, however, may be very different. Mean bottom temperatures have therefore been computed for

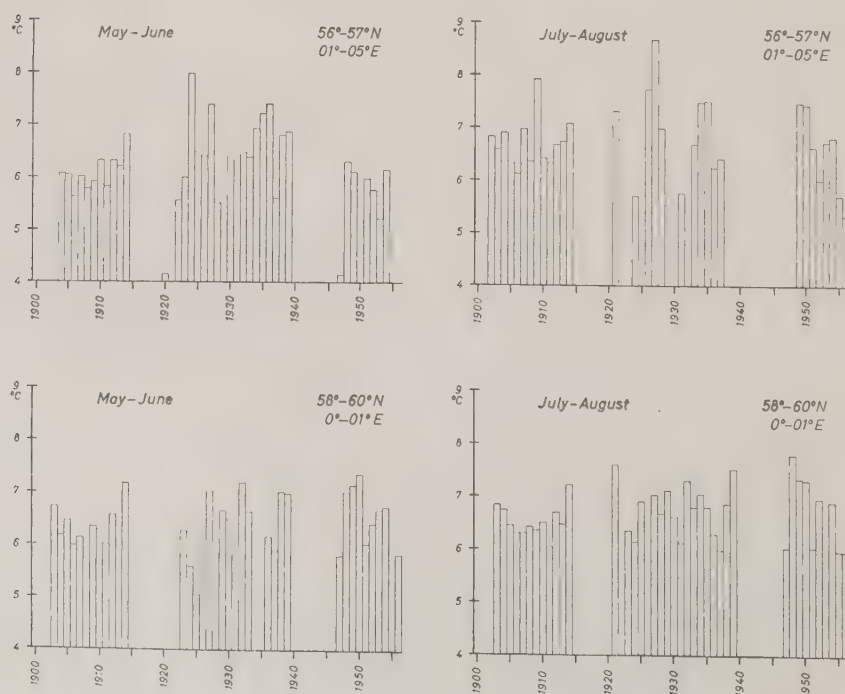


Figure 40. Average temperature of the bottom water in the central North Sea in the years 1900—1956.

Table 8. Sea temperature at 1 m. depth at Flødevigen

| Period        | Jan. | Feb. | Mar. | Apr. | May  | June  | July  | Aug.  | Sept. | Oct.  | Nov. | Dec. |
|---------------|------|------|------|------|------|-------|-------|-------|-------|-------|------|------|
| 1919—29 ..... | 3.06 | 1.60 | 2.33 | 4.63 | 8.8  | 12.28 | 15.52 | 15.63 | 13.94 | 10.84 | 7.1  | 4.70 |
| 1930—39 ..... | 3.41 | 2.73 | 2.34 | 4.79 | 9.39 | 13.34 | 16.61 | 17.37 | 14.95 | 11.45 | 8.09 | 5.22 |
| 1940—49 ..... | 2.69 | 1.67 | 1.87 | 4.36 | 9.46 | 13.38 | 16.84 | 16.99 | 15.04 | 11.73 | 8.11 | 5.86 |
| 1950 .....    | 3.6  | 2.2  | 3.2  | 5.8  | 10.8 | 13.0  | 16.1  | 17.5  | 15.1  | 12.2  | 7.6  | 4.6  |
| 1951 .....    | 1.3  | 1.1  | 1.0  | 3.6  | 8.8  | 13.5  | 15.0  | 16.1  | 15.1  | 12.6  | 8.5  | 7.4  |
| 1952 .....    | 5.2  | 3.1  | 2.1  | 4.5  | 9.8  | 11.2  | 14.6  | 15.9  | 13.6  | 9.6   | 6.0  | 4.2  |
| 1953 .....    | 2.8  | 2.6  | 3.2  | 5.3  | 9.9  | 15.6  | 16.4  | 16.5  | 14.7  | 12.3  | 9.1  | 7.0  |
| 1954 .....    | 5.5  | 0.9  | 0.4  | 4.1  | 9.6  | 13.4  | 15.3  | 15.7  | 14.6  | 11.0  | 7.6  | 5.5  |
| 1955 .....    | 3.7  | 1.5  | 0.9  | 3.7  | 7.4  | 12.4  | 17.8  | 19.2  | 16.1  | 12.2  | 8.4  | 6.1  |
| 1956 .....    | 3.0  | -0.2 | 0.0  | 3.8  | 8.0  | 12.6  | 15.6  | 15.0  | 13.8  | 11.7  | 7.7  | 5.5  |

May/June and July/August over the period 1900—1956 for two regions, one the Great Fisher Bank (56°-57°N., 01°-05°E.), the other in the vicinity of the Fladen Ground (58°-60°N., 00°-01°E.). These are shown in Figure 40. The data in the *Bulletin Hydrographique* published by the Council were used for the computations; for 1955 and 1956 the only observations available were from the German survey and research ships "Gauss" and "Anton Dohrn". The grand mean values for the whole period are as follows:—

| Region  |         | Period    | May/June | July/Aug. |
|---------|---------|-----------|----------|-----------|
| N.      | E.      |           | t°C.     | t°C.      |
| 56°—57° | 01°—05° | 1900/1956 | 6.23     | 6.74      |
| 58°—60° | 00°—01° | 1900/1956 | 6.47     | 6.69      |

Figure 40 clearly shows the variability of the bottom temperature from year to year. While in most years the temperatures do not differ much from the mean for the period (60—70% lie within  $\pm 0.5^{\circ}\text{C.}$  of the grand mean), the deviations are at times considerable. For instance, in the Great Fisher Bank region extremely warm bottom water, with a temperature of  $8.66^{\circ}\text{C.}$ , occurred in July/August 1927 and extremely cold bottom water, with a temperature of  $4.14^{\circ}\text{C.}$ , occurred in May/June

1947. It is noteworthy that the bottom temperatures in the last two years (1955 and 1956) are among the lowest of the period. These fluctuations are evidently associated with temperature conditions in the preceding winter; the winter 1926/27 was in fact very mild, and that of 1946/47 was extremely severe. The winters of 1954/55 and 1955/56 also were colder than usual.

G. PRAHM

## Hydrography of the Skagerak

(Table 8)

## Norwegian Waters

Observations of the temperature and salinity of the sea water were taken every working day at Flødevigen at 0, 1, and 15 metres depth.

In the Skagerak and the neighbouring fjords 161 hydrographical stations were worked.

The temperature was extremely low in winter 1956, and drift-ice occurred on the east coasts of Skagerak.

ALF DANNEVIG

Table 9. Long-period means of salinity and temperature at surface and bottom at the "Anholt Nord" lightvessel, together with the deviations from the mean

(From the Danish Meteorological Institute, Nautical Department)

| Month                | I              | II   | III  | IV   | V    | VI   | VII  | VIII | IX   | X    | XI   | XII  |
|----------------------|----------------|------|------|------|------|------|------|------|------|------|------|------|
| <b>Salinity</b>      | <b>Surface</b> |      |      |      |      |      |      |      |      |      |      |      |
| Mean .....           | 23.5           | 23.1 | 20.2 | 19.2 | 18.1 | 18.9 | 19.4 | 20.1 | 20.7 | 20.7 | 21.9 | 22.8 |
| Deviation 1956 ..... | 1.8            | —    | —    | -0.5 | 0.1  | -1.8 | -0.2 | 1.9  | 0.7  | 0.8  | 0.3  | 2.0  |
|                      | <b>Bottom</b>  |      |      |      |      |      |      |      |      |      |      |      |
| Mean .....           | 31.8           | 32.0 | 32.5 | 33.0 | 33.1 | 32.8 | 32.3 | 31.9 | 31.8 | 32.2 | 32.4 | 32.1 |
| Deviation 1956 ..... | 1.0            | —    | —    | 1.0  | 0.5  | -0.2 | 0.2  | -0.1 | 1.1  | 0.1  | 0.3  | 0.9  |
| <b>Temperature</b>   | <b>Surface</b> |      |      |      |      |      |      |      |      |      |      |      |
| Mean .....           | 2.2            | 1.4  | 1.9  | 4.5  | 9.4  | 14.2 | 16.8 | 16.7 | 14.5 | 10.9 | 7.1  | 4.1  |
| Deviation 1956 ..... | 0.5            | —    | —    | -1.0 | -0.7 | -0.2 | -0.3 | -1.4 | -0.3 | 0.6  | -0.2 | 0.9  |
|                      | <b>Bottom</b>  |      |      |      |      |      |      |      |      |      |      |      |
| Mean .....           | 6.1            | 4.7  | 4.3  | 4.3  | 4.9  | 6.7  | 9.7  | 12.7 | 13.1 | 12.1 | 10.2 | 8.1  |
| Deviation 1956 ..... | 0.0            | —    | —    | 0.1  | -0.6 | -0.7 | -0.8 | -0.6 | -0.6 | 0.5  | 0.8  | -0.2 |

Owing to ice the lightvessel was withdrawn from 4. February to 23. March.

Table 10. Long-period means of salinity and temperature at surface and bottom at the "Vyl" lightvessel, together with the deviations from the mean

(From the Danish Meteorological Institute, Nautical Department)

| Month                | I              | II   | III  | IV   | V    | VI   | VII  | VIII | IX   | X    | XI   | XII  |
|----------------------|----------------|------|------|------|------|------|------|------|------|------|------|------|
| <b>Salinity</b>      | <b>Surface</b> |      |      |      |      |      |      |      |      |      |      |      |
| Mean .....           | 32.6           | 32.4 | 32.2 | 32.4 | 32.3 | 32.6 | 32.5 | 32.4 | 32.6 | 32.4 | 32.4 | 32.9 |
| Deviation 1956 ..... | -0.5           | 0.3  | -0.4 | -0.6 | -0.3 | —    | -0.2 | -0.8 | -0.9 | -0.9 | -0.4 | -1.3 |
|                      | <b>Bottom</b>  |      |      |      |      |      |      |      |      |      |      |      |
| Mean .....           | 32.9           | 32.7 | 32.7 | 32.7 | 32.6 | 33.0 | 32.8 | 32.6 | 32.7 | 32.6 | 32.6 | 33.0 |
| Deviation 1956 ..... | -0.1           | 0.3  | -0.8 | -0.3 | -0.3 | —    | -0.1 | -0.7 | -0.6 | -0.6 | -0.4 | -1.1 |
| <b>Temperature</b>   | <b>Surface</b> |      |      |      |      |      |      |      |      |      |      |      |
| Mean .....           | 3.2            | 2.2  | 2.6  | 4.8  | 8.8  | 12.4 | 15.2 | 16.1 | 15.0 | 12.2 | 8.5  | 5.4  |
| Deviation 1956 ..... | 1.8            | -1.3 | -2.1 | -1.3 | -0.4 | —    | -1.0 | -1.1 | -0.4 | 0.6  | 0.9  | 1.3  |
|                      | <b>Bottom</b>  |      |      |      |      |      |      |      |      |      |      |      |
| Mean .....           | 3.8            | 2.6  | 3.0  | 4.8  | 8.0  | 11.1 | 14.1 | 16.0 | 15.1 | 12.7 | 9.1  | 6.2  |
| Deviation 1956 ..... | 1.5            | -1.3 | -2.6 | -2.2 | -2.4 | —    | -2.3 | -1.3 | -0.5 | 0.5  | 0.4  | 0.6  |

### Hydrography of the Kattegat Area

#### Danish Waters (Tables 9-10)

The Kattegat was covered with ice from the beginning of February to the beginning of March.

Temperatures generally were below normal throughout the year, especially so during the first 9 months.

Salinity deviated little from normal.

H. THOMSEN

it fluctuated irregularly. Bottom salinity at "Vinga" was a little below normal, whereas at "Svinbådan" it was markedly deficient, particularly during summer. This is obviously due to a strong admixture of Baltic water in the deeper layers of the southern Kattegat.

As a result of the cold weather, temperatures were on the whole fairly low, except in the low-salinity bottom water at "Svinbådan", in which the summer temperatures were above normal.

N. JERLOV

#### Swedish Waters (Table 11)

The surface salinity in spring 1956 was below the mean for 1950-1955; during the rest of the year

Table 11. Monthly means of salinity and temperature in 1956 at surface and bottom for the Swedish lightships "Vinga" and "Svinbådan", and deviations from 1950-55 means

| Month              | I              | II | III | IV    | V     | VI    | VII   | VIII  | IX    | X     | XI    | XII   |
|--------------------|----------------|----|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| <b>Salinity</b>    | <b>Surface</b> |    |     |       |       |       |       |       |       |       |       |       |
| "Vinga" .....      | 25.5           | —  | —   | 20.2  | 20.0  | 19.6  | 20.0  | 24.1  | 23.0  | 26.0  | 24.2  | 26.4  |
|                    | + 0.7          | —  | —   | -2.6  | -0.8  | -1.1  | -2.5  | + 2.4 | -1.2  | + 1.6 | + 0.3 | + 0.6 |
| "Svinbådan" .....  | 15.7           | —  | —   | 12.4  | 12.3  | 12.1  | 13.2  | 15.5  | 12.6  | 18.1  | 13.9  | 16.1  |
|                    | + 0.3          | —  | —   | -1.2  | -0.1  | -1.0  | -0.8  | + 2.9 | -3.2  | + 2.9 | -2.4  | -0.6  |
|                    | <b>Bottom</b>  |    |     |       |       |       |       |       |       |       |       |       |
| "Vinga" .....      | 33.3           | —  | —   | 34.6  | 34.1  | 33.5  | 33.7  | 32.5  | 33.5  | 32.8  | 34.0  | 33.4  |
|                    | -0.7           | —  | —   | + 0.3 | -0.3  | -0.6  | ± 0   | -1.2  | ± 0   | -0.9  | -0.1  | -0.3  |
| "Svinbådan" .....  | 25.2           | —  | —   | 31.3  | 30.7  | 26.9  | 24.2  | 21.8  | 24.2  | 27.4  | 26.4  | 27.0  |
|                    | -3.8           | —  | —   | -0.3  | -0.7  | -4.1  | -4.7  | -6.7  | -3.3  | -1.0  | -3.8  | -2.5  |
| <b>Temperature</b> | <b>Surface</b> |    |     |       |       |       |       |       |       |       |       |       |
| "Vinga" .....      | 2.4            | —  | —   | 3.6   | 8.9   | 14.1  | 16.5  | 15.3  | 14.2  | 11.3  | 6.8   | 5.6   |
|                    | -0.1           | —  | —   | -1.1  | -1.2  | -0.4  | -0.3  | -2.2  | -1.0  | -0.3  | -1.0  | + 0.5 |
| "Svinbådan" .....  | 2.4            | —  | —   | 3.0   | 7.9   | 14.3  | 16.3  | 15.5  | 14.0  | 11.2  | 6.0   | 4.8   |
|                    | + 0.2          | —  | —   | -1.8  | -1.9  | -0.3  | -0.6  | -1.7  | -1.2  | -0.1  | -1.8  | + 0.1 |
|                    | <b>Bottom</b>  |    |     |       |       |       |       |       |       |       |       |       |
| "Vinga" .....      | 5.4            | —  | —   | 4.2   | 4.5   | 5.2   | 7.1   | 12.3  | 11.9  | 12.5  | 9.1   | 7.3   |
|                    | -1.0           | —  | —   | -0.5  | -1.2  | -1.8  | -1.1  | + 1.3 | -1.3  | + 0.4 | -0.5  | -0.7  |
| "Svinbådan" .....  | 4.1            | —  | —   | 5.2   | 6.1   | 9.0   | 11.6  | 14.4  | 12.8  | 11.4  | 9.7   | 6.9   |
|                    | -1.8           | —  | —   | + 0.2 | + 0.5 | + 2.3 | + 1.7 | + 2.7 | + 0.5 | -0.6  | -0.8  | -0.8  |



## Plankton

### Scottish Plankton Investigations in 1956

#### Phytoplankton

The intensity of the sampling in the spring was less than in 1955, partly as "Scotia" was not available for this purpose and partly due to the abnormally bad weather.

In the northern North Sea the peak diatom figures in spring occurred in April and May and a lesser autumn peak in September/October. The July figures remained high, as in 1955, due to the numbers of *Rhizosolenia alata* f. *gracillima* which were, however, in poor condition. A general comparison between the two years suggests 1956 to have had the greater spring production and 1955 the greater autumn production. In February and March *Skeletonema costatum* was the most abundant species and dominated the collections taken near the Orkneys, but by early April the densest figures were found off the Norwegian coast with *S. costatum* and *Thalassiosira gravida*, the concentration off the east Scottish coast being much less. A belt of *Halosphaera*, more dense and more lasting than usual, extended down the east Scottish coast and some unusual species for the North Sea were also found: *Chaetoceros seiracanthus*, *C. brevis*, and *C. diadema*. By late April and May the densest concentrations were found off the Orkney and Shetland coast and some 60–100 miles off the southern Norwegian coast, with *T. gravida*, *C. debilis*, and *C. decipiens* dominant, whilst over the rest of the northern North Sea area smaller numbers of *Rhizosolenia*, *Chaetoceros*, and *Nitzschia* predominated.

The midsummer production of *Rhizosolenia alata* f. *gracillima* dominated the area from west Shetland to the central part of the northern North Sea although the cells were in poor condition with the chloroplasts becoming broken down or withdrawn from near the cell walls. High dinoflagellate figures were associated with them. Between this area and Faroe, in the oceanic water, *Nitzschia delicatissima*, *Thalassiothrix nitzschoides* and *Thalassiosira gravida* dominated.

In the autumn, along the east Scottish coast the dominant diatoms were *R. styliformis* and *C. decipiens* with *Ceratium fusus*, while in the southern part of the area investigated (about 56°N.) *R. alata*

was still present but with large numbers of *Ceratium tripos* and *C. furca*. *C. macroceros* occupied the central area. *C. decipiens* and *Thalassiothrix nitzschoides* were the dominant forms in the oceanic area of the Faroe Channel, but on the shelf *Rhizosolenia shrubsolei*, *Chaetoceros atlanticus*, and *Ceratium furca* were more common.

#### Zooplankton

##### North Sea

After rather sparse sampling in the earliest months of the year the northern North Sea was extensively sampled in April. *Calanus* was abundant in the area north of 58°N. especially in the area east of the Orkneys and Fair Isle, but it was less common to the north-east and east of Shetland and in the east central North Sea. This lasted until midsummer, but in August there were great increases in the numbers of *Calanus* found to the north-east of Shetland, although the east central North Sea still remained sparsely populated. By November and December *Calanus* had become abundant off the south-east Scottish coasts to at least 0° but had become reduced north of 61°N.

Associated with *Calanus* in April, but more widely distributed towards the south-east area were unusually large numbers of *Oikopleura labradoriensis*. This was, at times, volumetrically the dominant form in the collections, but its numbers diminished by the end of April and thereafter it was of little significance. *Sagitta elegans* was again the dominant Chaetognath in the area but *S. setosa* was abundant on the Fisher Bank and present over a much wider area than in recent years east of 1°E. and reaching 61°N. At this time there was a slight inflow of oceanic species round the north of Shetland, bringing with it *Sagitta serratodentata*, *Chelophyes*, *Sulculeolaria*, and *Hippopodius*. There was evidence of only a slight incursion through the Fair Isle Passage carrying with it *S. serratodentata*, *Chelophyes*, and *Sulculeolaria*.

Sampling in the northern North Sea in summer (July and August) showed little evidence of inflow of oceanic species round the north of Shetland and into the North Sea, except east of 3°E.

where there appeared to be an incursion in the subsurface waters (*Lensia*, *Chelophyes*, *Solmissus*, and *Arachnactes*) with dense local patches of *Meganyctiphanes*. The slight trickle of oceanic species through the Fair Isle Passage continued, bringing with it *Cosmetira*, *Agalma*, and *Lepas anserifera* to the area east of the Moray Firth. During this period *Calanus* was increasing in the northern North Sea with dense local patches of *Themisto*. A patch of *Pleurobrachia* was becoming more evident east of the Firth of Forth and *S. setosa* was widespread in small numbers east of 0°.

In the autumn the inflow of oceanic species to the northern North Sea was still slight along the 61°N. line from Shetland to Norway, and only a few of the oceanic species dominating the plankton of the Faroe Channel invaded the area. *Limacina retroversa* was dense in places north of 60°. *Sagitta setosa* had spread even further west to 1°W. but was most abundant east of 0°. East of the Firth of Forth the patch of *Pleurobrachia* had increased but did not reach sufficiently high numbers to reduce the *Calanus* and *Sagitta elegans* community which existed there with *Aglantha* and *Themisto*, etc.

#### North and west of Scotland

The Near Northern Seas area off the shelf to the north and west of Scotland was investigated in July, August, and November. It showed the usual community of Atlantic species, with Lusi-

tanian species close to the edge of the shelf and penetrating beyond the Wyville Thomson Ridge but not reaching as far as Shetland. The Lusitanian species included a number of siphonophores (*Nectopyramis thetis*, *Rosacea plicata*, *Vogtia* [3 species], *Lensia fowleri*, *Chuniophyes multidentata*), medusae, and the Pteropod *Peraclis moluccensis*. The Atlantic species included *Arachnactes* in great numbers, *Agalma*, *Lensia conoidea*, *Sulculeolaria biloba*, and *Salpa fusiformis*; all of these penetrated across the Faroe-Flugga line in November but were not found in the North Sea. *Dolioletta* was common in July but was not taken later. This community is further dealt with in the report to the Distant Northern Seas Committee.

J. H. FRASER

#### Herring larvae

The 1956 east coast herring larvae surveys were planned to attempt to follow one small concentration of newly hatched larvae during its planktonic phase. Cruises were carried out by "Scotia" and "Clupea" during the following periods, 5. to 12. September, 11.—19. September, 16.—24. October, 9.—24. November, and 4.—10. December. On the first cruise a dense concentration of early larvae was located at 57°00'N., 1°00'W. By 19. September it had moved 15 miles to the south and by December it was about 50 miles S. by E. of its central position on 5. September (Berwick East Bank).

A. SAVILLE

## THE FISH

## Plaice

German Investigations in the South-Eastern  
North Sea in 1956

(Figures 41-47; Tables 12-16)

In 1955 routine investigations of the plaice populations of the German Bight were continued by Germany as in previous years; that is to say, two cruises were made with the research vessel "Uthörn" (29. April to 17. May and 31. August to 9. September). Owing to very bad weather in spring only 14 of the 20 fixed stations could be worked; in September 19 stations were worked.

In 1956 the programme was changed in so far as the cruise was carried out with the R/V "Anton Dohrn", as it will be in future. Under the new plan, one cruise with the "Anton Dohrn" will be undertaken every year instead of the two with the "Uthörn", but the area covered will be much greater than formerly, extending to  $56^{\circ}10'$  in the north and to  $2^{\circ}$  E. on the west. This thus comprises the whole south-eastern North Sea, including the young-fish grounds in the German Bight, as well as the feeding grounds and the main deep-water grounds fished by the German high-sea cutters. The Flemish Bight is not included in the area.

In 1956 35 stations were worked in this area, 12 of them being former "Uthörn" stations (Graa-dyb I and II, List II, Westerland II, Amrum II, Hever III, Otzumer Balje II and III, and the four stations round Helgoland), the other 23 being spread over the main fishing grounds. We hope to get in this way a good sample of the plaice stock of the area. Only the small fish of the I-group, living mostly in inshore waters, will not be adequately represented.

The "Anton Dohrn" cruises will be carried out at the end of June or the beginning of July.

As in former years, a haul of half an hour's duration will be made at every station with a cutter trawl, as was done by the "Uthörn", the only difference being that we now fish with a "Decksteert" (covered cod-end), as was the pre-war practice.

In this way the need to convert our catches into "covered cod-end catches" is avoided, and a more reliable basis is obtained for calculating the density of the stock and the strength of the year-classes when conversion factors are used.

Market investigations—long desired—were started in 1955, but could not be carried out on the pre-war scale, nor even on an adequate scale, since

staff to do the work was lacking. We hope, however, that in the near future the work can be carried out more satisfactorily.

The change in methods of investigation requires that caution be used in comparing the results of former years with those from 1956 and onwards, for the material obtained by the "Uthörn" is not comparable in every respect with the "Anton Dohrn's". To give one example, the season in which the investigations are made is not the same. We know that as a result of migrations the length and age compositions of the stock change with the season. Moreover, we must reckon on the "fishing power" of the two ships being different. In addition, only 12 of the "Uthörn's" stations are fished by the "Anton Dohrn", and we cannot expect these 12 stations to give as full information about the composition and density of the stock as the 20 "Uthörn" stations in this area.

## Research-ship investigations

1. Cruises with the "Uthörn", spring 1955, 14 stations; 1850 fish were measured and their ages determined.

2. Cruise with the "Uthörn", autumn 1955, 19 stations; 1892 fish were measured and their ages determined.

3. Cruise with the "Anton Dohrn", summer 1956, 12 stations inside the German Bight; 3535 fish were caught, and 2485 otoliths taken. 23 stations outside the German Bight (six of them yielded no plaice); 442 measurements and age determinations.

4. Market investigations:—

1955: 24 cutter landings were analysed, 10 of them in respect of length composition only, the rest in respect of age also. 10,440 measurements and 5,389 age determinations.

1956: 16 cutter landings, comprising 7,495 fish were investigated in respect of length and age composition.

## Results of the research-ship investigations

(a) Age composition of the catches (Fig. 41)

The age composition of the stock in spring differed very little from that in autumn 1954, except that the 1953 year-class (age-group II) had become much more prominent in the catches (73%). This was to be expected, since in the preceding autumn these fish—then age-group I—were too small to be sampled representatively with our net. Corresponding to the increase in the 1953 year-class, a decrease in the 1952 year-class



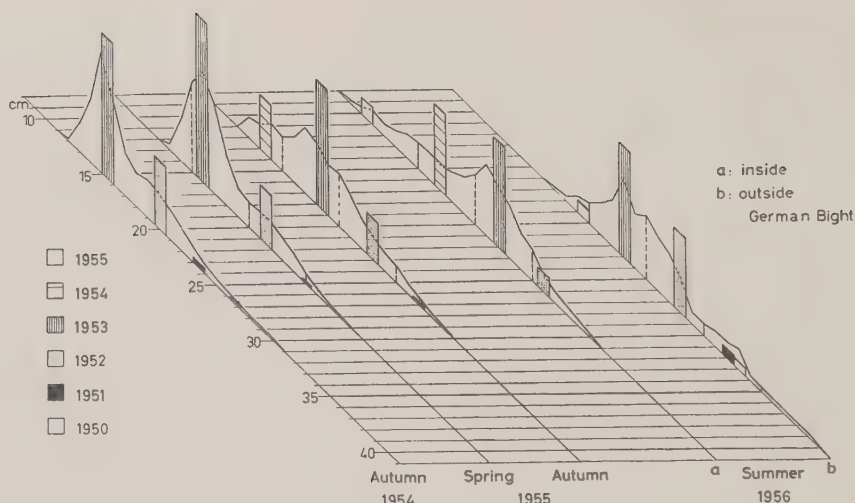


Figure 41. Length distribution (% curves) and age composition (%) of the total catches from autumn 1954 to summer 1956.

from 31% to 24% was observed. These two youngest age-groups together formed 97% of the catches, and older fish were practically absent. In autumn 1955 the new 1954 year-class was first found in the catches, of which it formed 24%. Due to the appearance of this relatively good brood the proportion of age-groups II and III declined to 55 and 18% respectively. Considering only the catches inside the German Bight, we found that in 1956 the 1954 year-class was much more abundant than in autumn 1955, while the 1953 year-class had declined somewhat (37 and 47% respectively). The relative decline (and as we shall see later, the absolute decline also) of the 1952 year-class to only 8% is noteworthy. The proportion of age-group I (1955 year-class) is relatively low (at 7%). Although the difference in season is to be taken into account in this connexion, a higher pro-

portion was nevertheless expected, as the covered cod-end was used. Fish over 4 years old amounted only to 1%.

Outside the German Bight in relatively deep water (23 stations) we found no fish of the I-group, and only 5% were of the 1954 year-class. Nearly 50% of the catches were made up of the 1953 year-class and 35% of the 1952 year-class. Older fish were also scarce, amounting only to 11% of the total catch.

#### (b) Growth (Fig. 42)

In both 1955 and 1956 the plaice grew very well as compared with the years immediately following 1948. It seems that the absence of relatively older and larger fish had reduced the competition for food. Growth in the deeper water must have been much better than on the young-fish grounds in the

Table 12. Age composition (%) of plaice in the catches from 1954 to 1956

|             | Age-groups |      |      |      |      |       | Number of fish examined |
|-------------|------------|------|------|------|------|-------|-------------------------|
|             | I          | II   | III  | IV   | V    | VI+   |                         |
| Spring 1954 | —          | 77   | 9    | 10   | 3    | 1     | 5,507 <sup>1)</sup>     |
| Autumn 1954 | 63         | 31   | 3    | 2    | 1    | +     | 11,086 <sup>1)</sup>    |
| Year-class  | 1953       | 1952 | 1951 | 1950 | 1949 | 1948— |                         |
| Spring 1955 | +          | 73   | 24   | 1    | 1    | 1     | 2,941 <sup>1)</sup>     |
| Autumn 1955 | 24         | 55   | 18   | 1    | 1    | +     | 2,737 <sup>1)</sup>     |
| Year-class  | 1954       | 1953 | 1952 | 1951 | 1950 | 1949— |                         |
| Summer 1956 | 7          | 37   | 47   | 8    | 1    | +     | 3,535 <sup>2)</sup>     |
| Year-class  | —          | 5    | 49   | 35   | 4    | 7     | 442 <sup>3)</sup>       |
| Year-class  | 1955       | 1954 | 1953 | 1952 | 1951 | 1950— |                         |

<sup>1)</sup> Converted into covered cod-end catches.

<sup>2)</sup> 12 catches inside the German Bight.

<sup>3)</sup> 23 catches outside the German Bight, in relatively deep water.

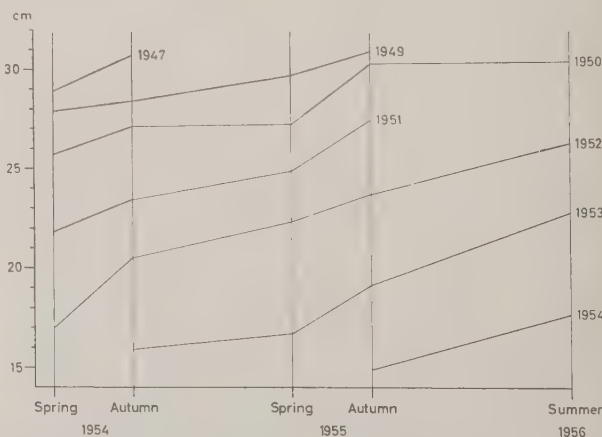


Figure 42. Growth curves of year-classes from 1947 to 1954 in the German Bight over the period 1954 to 1956.



Table 13. Average length (cm.) of the age-groups in 1954, 1955, and 1956

|                 | Age-groups |      |      |      |      |      |      | Mean length of total catch |
|-----------------|------------|------|------|------|------|------|------|----------------------------|
|                 | I          | II   | III  | IV   | V    | VI   | VII  |                            |
| Spring 1954     | —          | 17.0 | 21.8 | 25.7 | 27.9 | 29.7 | 28.9 | 18.2                       |
| Autumn 1954     | 15.9       | 20.5 | 23.4 | 27.1 | 28.5 | —    | 30.7 | 17.9                       |
| Year-class 1953 | 1953       | 1952 | 1951 | 1950 | 1949 | 1948 | 1947 |                            |
| Spring 1955     | —          | 16.7 | 22.3 | 24.9 | 27.2 | —    | —    | 18.3                       |
| Autumn 1955     | 14.9       | 19.1 | 23.7 | 27.4 | 30.3 | 30.9 | —    | 19.3                       |
| Year-class 1954 | 1954       | 1953 | 1952 | 1951 | 1950 | 1949 | —    |                            |
| Summer 1956     | —          | 17.7 | 22.8 | 26.3 | —    | —    | —    | 20.7 <sup>1)</sup>         |
| Year-class 1954 | —          | 20.1 | 23.9 | 28.5 | 32.7 | —    | —    | 26.4 <sup>2)</sup>         |
|                 | 1954       | 1953 | 1952 | 1951 | —    | —    | —    |                            |

<sup>1)</sup> 12 catches inside the German Bight.<sup>2)</sup> 23 catches outside the German Bight in relatively deep water.

German Bight, as the high figures in Table 13 show. Some errors might have resulted from the small number of fish examined, but the findings are borne out by the commercial catch data.

**(c) Density of stock**

Judging from the means of the catch per unit effort in 1955 we must conclude that the plaice stock had become much less dense (1110 fish per hour's fishing in autumn 1954 against 420 in spring and 288 in autumn 1955). These figures, however, may be deceptive. Cold, stormy, and rainy weather may have brought down the catches in both spring and autumn 1955. Moreover, in spring 1955 several stations were omitted that had yielded heavy catches in 1954. Nevertheless the results of the autumn 1955 catches (19 stations) support the idea of an absolute decline in density, though it may perhaps be inferior to that indicated by the figures in Table 14. The results of the cruise in summer 1956 fall in with this assumption. The catch per hour under good weather conditions was then very much higher (ca. 590 fish) than in autumn 1955, though there are no signs of the entry of large numbers of a new year-class, but it is not nearly as high as in autumn 1954. The cruise in 1956 and the analysis of the cutter landings tend to show that the decrease was brought about by an early emigration of the 1952 year-class and, to some extent, of the 1953 year-class. The 1952 year-class generally formed a high proportion of the cutter landings in 1955 and 1956, and also in the offshore catches of the "Anton Dohrn" in 1956, whilst it fell off heavily inside the German Bight, as Table 14 shows.

Table 14. Catch per hour of the various age-groups in 1954 to 1956

|                 | Age-groups |      |      |      |      |       | Mean catch per hour |
|-----------------|------------|------|------|------|------|-------|---------------------|
|                 | I          | II   | III  | IV   | V    | VI+   |                     |
| Spring 1954     | —          | 449  | 52   | 55   | 15   | 7     | 578                 |
| Autumn 1954     | 699        | 344  | 30   | 24   | 5    | 7     | 1,109               |
| Year-class 1953 | 1953       | 1952 | 1951 | 1950 | 1949 | 1948- |                     |
| Spring 1955     | —          | 307  | 103  | 6    | 3    | 1     | 420                 |
| Autumn 1955     | 69         | 158  | 52   | 3    | 2    | 4     | 288                 |
| Year-class 1954 | 1954       | 1953 | 1952 | 1951 | 1950 | 1949- |                     |
| Summer 1956     | 39         | 217  | 275  | 47   | 4    | 7     | 589 <sup>1)</sup>   |
| Year-class 1955 | —          | 2    | 20   | 14   | 2    | 2     | 40 <sup>2)</sup>    |
|                 | 1955       | 1954 | 1953 | 1952 | 1951 | 1950- |                     |

<sup>1)</sup> and <sup>2)</sup>, see Table 12.**(d) Relative strengths of year-classes**

In earlier reports (Ann. Biol., X (1953): 133-36 and XI (1954): 112-14; Ber. Dtsch. Komm. Meeresforsch., XIV (2): 83-108) estimates were attempted for the relative strength of the year-classes from their abundance in the II and III groups, and we obtained the following figures for 1946 and onwards:—

|                |      |      |      |      |      |      |
|----------------|------|------|------|------|------|------|
| Year-class ... | 1947 | 1949 | 1940 | 1948 | 1946 | 1951 |
| Index .....    | 100  | 43   | 40   | 28   | 22   | 9    |

Continuing this series with the data for 1955 and 1956 we obtain an index of 43 for the 1952 year-class and of 47 for the 1953 year-class. The data for 1955 are not strictly comparable with the remainder, however, and the 1952 year-class may have emigrated from the German Bight very early. In that case the above figures would tend to be too low. At any rate the 1952 and 1953 year-classes are the richest in post-war years, apart from the 1947 year-class. This is of great importance to the future commercial fishery. As the 1954 year-class also seems to be of more than medium strength, the fishery will depend on three relatively strong year-classes; the landings are thus expected to rise for the next few years.

**(e) Length distribution (Fig. 41)**

In 1955 and 1956 the plaice in the German Bight were relatively small, in consequence of the addition to the stock of the rich broods of recent years. In spring 1955 only 3.1% of the fish exceeded 25 cm., the limit for marketable fish; later on this proportion slowly increased, reaching 9.1% in autumn 1955 and 14.0% in summer 1956. Outside the German Bight 55% of the fish were of marketable size.

Table 15. Marketable fish in the catches (%)

|             |                                    | Age-groups |    |     |    |     |     |                    |
|-------------|------------------------------------|------------|----|-----|----|-----|-----|--------------------|
|             |                                    | I          | II | III | IV | V   | VI  | VII Total          |
| Spring 1954 |                                    | 0          | +  | 11  | 64 | 84  | 89  | 10.9               |
| Autumn 1954 |                                    | 0          | 3  | 32  | 79 | 85  | 100 | 4.3                |
| Year-class  | 1953 1952 1951 1950 1949 1948 1947 |            |    |     |    |     |     |                    |
| Spring 1955 |                                    | 0          | 0  | 11  | 39 | 83  | 75  | 3.1                |
| Autumn 1955 |                                    | 0          | 1  | 33  | 81 | 100 | 90  | 9.1                |
| Year-class  | 1954 1953 1952 1951 1950 1949 1948 |            |    |     |    |     |     |                    |
| Summer 1956 |                                    | 0          | 0  | 15  | 63 | 68  | 100 | 14.0 <sup>1)</sup> |
|             |                                    | —          | 0  | 29  | 88 | 94  | 100 | 55.0 <sup>1)</sup> |
| Year-class  | 1955 1954 1953 1952 1951 1950 1949 |            |    |     |    |     |     |                    |

<sup>1)</sup> See Table 12.

### Market investigations

As already mentioned, insufficient cutter landings were examined to permit the calculation of the age composition of the fish landed each month.

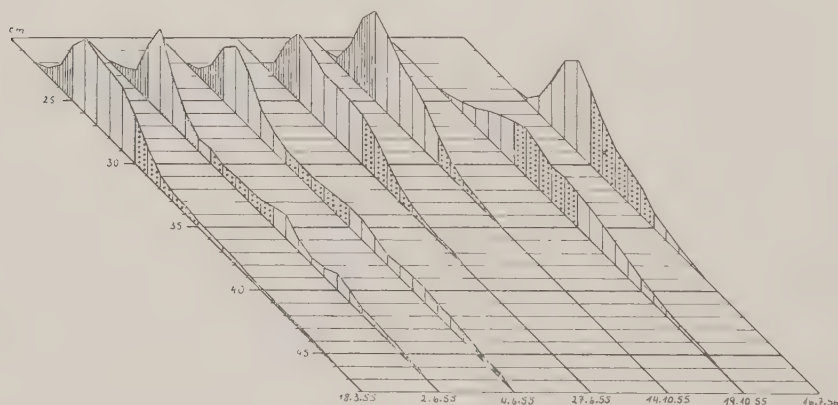
The samples were grouped according to area as follows, mixed samples being rejected:—

Area A: Fishing grounds between the North Friesian coast and the 40 m. contour to the west.

Area B: Fishing grounds between the East Friesian coast and the 40 m. contour, including the White Bank and "Austerngrund".

Area C: Northern and Southern Mud Bank, Monkey Bank, Tail End, and Coffee Soil.

Area D: All grounds west of Areas B and C.



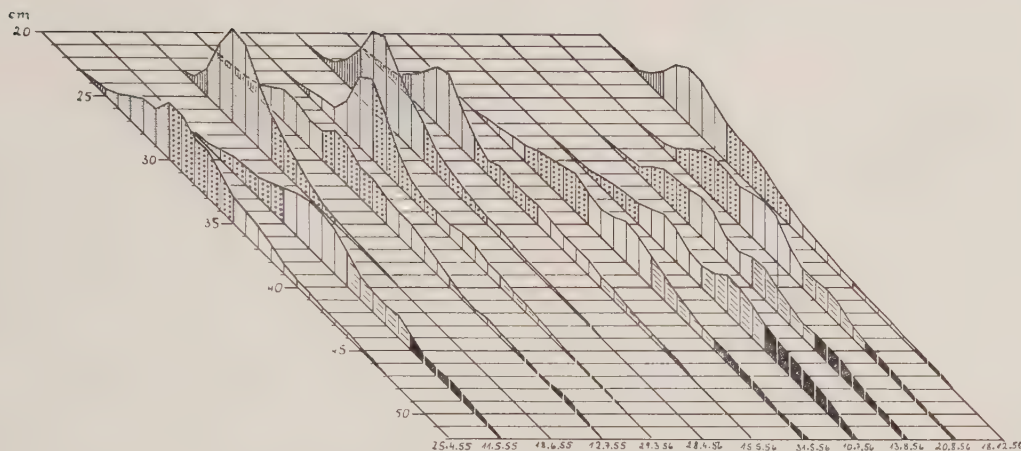


Figure 45. Length composition of the cutter landings from Area C (% curves).

The length compositions are illustrated in Figures 43—46. Relatively small fish, from 24 to 30 cm., predominated in Area A till 14. October 1955. By 19. October 1955 the smaller fish had almost disappeared. In summer 1956 the fish were somewhat larger than in 1955, the majority ranging from 26 to 35 cm. in length. In Area B the small fish were absent in the early months of 1955; they appeared in August, that is, later than in Area A. The fish caught in June 1956 were extremely small. In Area C, a fairly extensive area, the length composition of the catches varies much more than in Areas A and B. In general small fish up to 30 cm. length were by far the most numerous up to May 1956. Later on the larger fish increased in numbers. In December 1956 a wave of small, young fish seems to have entered the stock.

The age composition of the catches is shown in Figure 47. We see that—with few exceptions—the 1952 year-class was by far the most numerous in all areas in both 1955 and 1956. Next in order comes the 1950 year-class whilst the 1951 year-class, which was found to be the poorest of the post-war year-classes in the German Bight, seems to have been very poor in open waters also. In several catches in both years the rich 1947 year-class (present as age-groups VIII and IX) was still to be found in very high percentages. Younger fish of the 1953 year-class were caught in Area B in June 1956, in Area D in August 1956, and in Area C in December 1956. It seems that this year-class did not migrate to deeper water as early as the 1952 year-class.

As seen from Table 16, the mean lengths of the age-groups may vary considerably from catch to catch and from area to area. This is to be explained only as the result of quite different growth conditions in the different localities and of the mixing of fish of varying growth-rates.

A. KOTTHAUS

Table 16. Mean lengths of the age-groups in the cutter landings

|        | Date       | Age-groups |      |        |      |        |      | Mean length, all groups |
|--------|------------|------------|------|--------|------|--------|------|-------------------------|
|        |            | III        | IV   | V      | VI   | VII    | VIII |                         |
| Area A | 27. 6. 55  | 26.7       | 29.4 | 30.7   | 31.7 | 33.5   | 35.1 | 28.5                    |
|        | 14. 10. 55 | 27.0       | 28.8 | 30.7   | —    | —      | 33.5 | 28.1                    |
|        | 19. 10. 55 | 30.3       | 33.5 | 34.7   | 37.4 | 39.4   | 41.2 | 34.5                    |
|        | 16. 7. 56  | 27.7       | 30.4 | 32.1   | 33.3 | —      | —    | 30.7                    |
| Area B | 19. 8. 55  | 28.2       | 29.7 | 30.4   | 31.5 | 32.8   | 35.7 | 29.5                    |
|        | 20. 10. 55 | 27.2       | 31.0 | —      | —    | —      | —    | 29.0                    |
|        | 11. 1. 56  | —          | 29.9 | 34.8   | 35.5 | 35.7   | 37.3 | 35.7                    |
|        | 12. 3. 56  | —          | 29.5 | 34.0   | 37.0 | 39.6   | 41.5 | 33.3                    |
| Area C | 6. 6. 56   | 22.8       | 26.4 | 29.0   | 34.4 | —      | 35.8 | 23.0 <sup>1)</sup>      |
|        | 18. 6. 55  | 27.8       | 28.8 | 30.7   | 31.2 | —      | 32.4 | 29.1                    |
|        | 12. 7. 55  | (35.0)     | 37.1 | 39.2   | 40.9 | 43.2   | 44.3 | 44.0                    |
|        | 29. 3. 56  | —          | 30.6 | 33.9   | 35.6 | 38.1   | 41.9 | 32.5                    |
| Area D | 28. 4. 56  | —          | 28.1 | 30.7   | 33.8 | 37.9   | —    | 29.0                    |
|        | 15. 5. 56  | —          | 29.3 | 33.8   | 36.8 | 38.5   | 42.6 | 33.0                    |
|        | 31. 5. 56  | —          | 34.3 | 38.9   | 40.0 | —      | —    | 38.7                    |
|        | 10. 7. 56  | —          | 35.8 | 39.1   | 41.2 | 43.1   | 45.3 | 42.3                    |
| Area D | 13. 8. 56  | —          | 37.1 | 40.0   | 42.7 | 44.4   | —    | 41.5                    |
|        | 20. 8. 56  | —          | 35.5 | —      | 39.3 | —      | —    | 38.1                    |
|        | 18. 12. 56 | 28.6       | 32.2 | 35.5   | 39.1 | 41.6   | —    | 31.3                    |
|        | 21. 8. 56  | 28.1       | 30.6 | 32.5   | 33.0 | —      | —    | 30.3                    |
| Area D | 23. 8. 56  | 28.5       | 30.9 | 31.7   | 34.3 | (33.6) | 40.7 | 31.4                    |
|        | 19. 10. 56 | 27.9       | 29.8 | (29.4) | 32.4 | 37.3   | 38.1 | 28.9                    |
|        | 31. 10. 56 | 29.4       | 34.6 | 39.4   | 40.8 | 42.5   | 45.3 | 41.2                    |

<sup>1)</sup> This includes unmarketable fish.

## Danish Plaice Investigations in the North Sea, 1956

(Table 17)

### 1. Young plaice in the Danish Waddensea

Routine hauls with the young-fish trawl were carried out between 22. June and 1. July, between 23. and 28. August, and between 22. October and 1. November. In all 131 hauls, each of 15 minutes duration, were made. In the northern area (Ho Bay—Knude Deep) 76 hauls were made. The mean numbers caught per hour were 104 0-group plaice (1956 year-class) and 62 I-group plaice (1955 year-class); the mean for the period 1935 to 1956 is 202 0-group and 164 I-group plaice. In the southern area (Juvre Deep—Højer Flak) 55 hauls were made. The mean numbers of plaice caught per hour were 105 0-group and 12 I-group; the corresponding mean values for 1953—56 are 66 0-group and 38 I-group.

### 2. The stock of plaice off Esbjerg

Trawling with a 50 ft. otter-trawl with a 9 mm. mesh in the cod-end, was carried out from 13. to

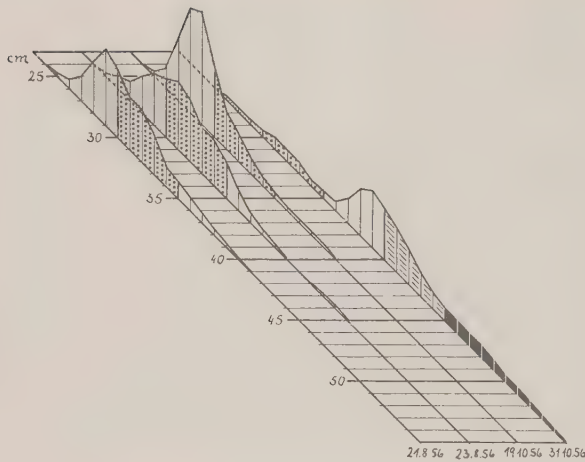


Figure 46. Length composition of the cutter landings from Area D (% curves).

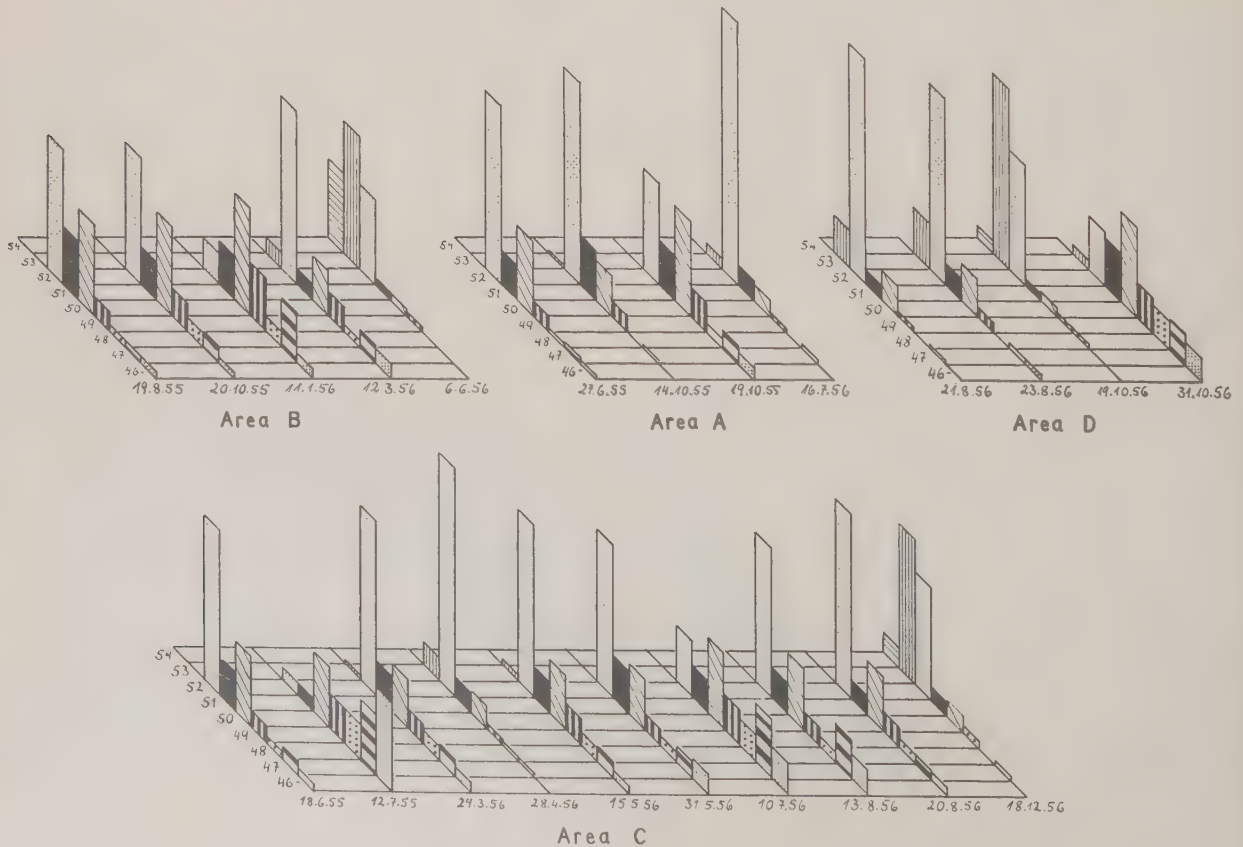


Figure 47. Age composition of the cutter landings from the four areas together (%).



Table 17. Weight distribution and mean weight of plaice from various localities in the North Sea. 347 Esbjerg landings, April—September 1956

( ) = corresponding values for 1955

|                                                           | Depth<br>(fath.) | Number<br>of<br>landings | Weight distribution, % |         |         |         |         | Mean<br>weight<br>g. |
|-----------------------------------------------------------|------------------|--------------------------|------------------------|---------|---------|---------|---------|----------------------|
|                                                           |                  |                          | Cat. 4                 | Cat. 3  | Cat. 2  | Cat. 1  | Cat. 0  |                      |
| Horns Reef .....                                          | 5—21             | 153                      | 74 (75)                | 22 (20) | 3 (4)   | 1 (1)   | 0 (0)   | 235 (236)            |
| Helgoland .....                                           | 14—24            | 2                        | 74 (37)                | 20 (34) | 4 (19)  | 2 (10)  | 0 (0)   | 237 (294)            |
| Clay Deep—Holland .....                                   | 10—40            | 75                       | 72 (64)                | 20 (25) | 5 (6)   | 2 (4)   | 1 (1)   | 241 (242)            |
| 50—90 miles W.S.W. of Esbjerg .....                       | 20—24            | 18                       | 76 —                   | 20 —    | 3 —     | 1 —     | 0 —     | 234 —                |
| Bløden .....                                              | 17—28            | 32                       | 49 —                   | 35 —    | 10 —    | 5 —     | 1 —     | 286 —                |
| Total (landings from areas dominated by category 4) ..... | 5—28             | 280                      | 70 (67)                | 23 (24) | 5 (6)   | 2 (3)   | 0 (0)   | 241 (247)            |
| Dogger .....                                              | 12—26            | 22                       | 10 (10)                | 15 (16) | 15 (17) | 30 (40) | 30 (18) | 536 (527)            |
| N. of Dogger .....                                        | 20—42            | 45                       | 15 (2)                 | 26 (9)  | 20 (17) | 31 (33) | 9 (20)  | 441 (631)            |
| Total (landings from areas dominated by category 1) ..... | 12—42            | 67                       | 13 (8)                 | 22 (14) | 18 (17) | 31 (42) | 16 (19) | 467 (545)            |
| Grand Total .....                                         | 5—42             | 347                      | 62 (55)                | 23 (22) | 7 (8)   | 6 (11)  | 3 (4)   | 260 (277)            |

15. June; during this time 23 hauls of 10 minutes duration were made. In depths less than 10 m. 384 plaice were caught per hour (mean for 1950-56, 570 per hour). In depths from 10 m. to 29 m. the number per hour was 263 (mean for 1950-56, 340).

In depths less than 10 m. the age distribution (number caught per hour) was:—

|            | I   | II  | III |
|------------|-----|-----|-----|
| 1954 ..... | 256 | 58  | 0   |
| 1955 ..... | 236 | 682 | 42  |
| 1956 ..... | 168 | 213 | 3   |

In depths from 10 to 29 m. the corresponding numbers were:—

|            | I  | II  | III | IV | V |
|------------|----|-----|-----|----|---|
| 1954 ..... | 27 | 17  | 1   | 2  | 4 |
| 1955 ..... | 48 | 298 | 103 | 2  | 1 |
| 1956 ..... | 43 | 167 | 39  | 14 | 0 |

The 1953 year-class (in 1956 the III-group) was not present in the catches with the strength which might perhaps have been expected, from the large catches of this year-class in 1955.

As in the preceding year marketable plaice (26 cm. and above) caught in 1956, were mostly of the 1952 year-class. The percentages were:—

|            | III | IV | V | VIII |
|------------|-----|----|---|------|
| 1955 ..... | 82  | 9  | 7 | 2    |
| 1956 ..... | 33  | 65 | 2 | —    |

### 3. Landings of plaice in Esbjerg

During the period April—November 1956, 347 landings of plaice were examined on Esbjerg market. The same procedure was followed as in 1955 (Ann. Biol., XII: 94). The weight of fish landed in each market category is shown in Table 17. As in 1955, the landings originated from areas in which either small plaice (category 4) predominated or large

plaice (category 1) predominated. The mean weight in each category was:—

| Category | 12 landings dominated<br>by small plaice | 6 landings dominated<br>by fairly large plaice |
|----------|------------------------------------------|------------------------------------------------|
|          | Mean weight, g.                          | Mean weight, g.                                |
| 0        | 852                                      | 1110                                           |
| 1        | 607                                      | 627                                            |
| 2        | 458                                      | 498                                            |
| 3        | 319                                      | 363                                            |
| 4        | 214                                      | 250                                            |

The estimate of the mean weight of plaice landed from each area (Table 17) is based on the mean weight in each market category, as shown above.

Age analyses were carried out on samples from 18 landings. In all, 3,108 plaice were dealt with. In 15 landings the IV-group (1952 year-class) predominated. These landings include 3 from the Dogger Bank and the northern North Sea (large plaice). In 2 landings the III-group predominated (Horns Reef in August, Helgoland in June) and in 1 the VI-group predominated (Dutch coast, small plaice). In 1955, in 6 out of 12 landings (Ann. Biol., XII: 96) the III-group (1952 year-class) predominated, in 5 the V-group (1950 year-class), and in 1 the VIII-group (1947 year-class, off Helgoland, small plaice). The 1952 year-class became still more prominent in 1956.

Of those examined in 1956 there were fewer landings from areas characterized by large plaice than in 1955. In 1956 an important fishery was situated well offshore from Esbjerg but still east of the Dogger Bank. This area (the Bløden Ground, about 50—90 nautical miles W.S.W. of Esbjerg) was not represented in the landings examined in 1955. These differences may be due to weather

Table 18. Length distribution of Lowestoft and Grimsby landings  
(Thousands of fish)

| Length<br>Group<br>(cm.)       | Lowestoft<br>Steam<br>and Motor<br>1954/55 |      | Grimsby<br>Steam<br>1954/55 |      | Lowestoft<br>Steam<br>and Motor<br>1955/56 |      | Grimsby<br>Steam<br>1955/56 |      | Lowestoft<br>Steam<br>and Motor<br>1956/57 |      | Grimsby<br>Steam<br>and Motor<br>1956/57 |      | Grimsby<br>Motor Seine<br>1956/57 |      |
|--------------------------------|--------------------------------------------|------|-----------------------------|------|--------------------------------------------|------|-----------------------------|------|--------------------------------------------|------|------------------------------------------|------|-----------------------------------|------|
|                                | Nos.                                       | %    | Nos.                        | %    | Nos.                                       | %    | Nos.                        | %    | Nos.                                       | %    | Nos.                                     | %    | Nos.                              | %    |
| 20—24 .....                    | 24                                         | 0.1  | 8                           | 0.1  | 37                                         | 0.2  | 13                          | 0.1  | 45                                         | 0.3  | 7                                        | 0.0  | 11                                | 0.2  |
| 25—29 .....                    | 7,108                                      | 36.4 | 1,857                       | 12.3 | 5,465                                      | 32.6 | 2,002                       | 13.2 | 4,918                                      | 33.1 | 1,810                                    | 15.5 | 584                               | 9.5  |
| 30—34 .....                    | 8,107                                      | 41.5 | 5,782                       | 38.2 | 6,872                                      | 41.1 | 6,020                       | 39.7 | 5,774                                      | 38.9 | 4,260                                    | 36.6 | 1,508                             | 24.5 |
| 35—39 .....                    | 2,711                                      | 13.9 | 4,006                       | 26.4 | 2,713                                      | 16.2 | 3,805                       | 25.1 | 2,296                                      | 15.5 | 2,831                                    | 24.3 | 1,848                             | 30.0 |
| 40—44 .....                    | 975                                        | 5.0  | 2,074                       | 13.7 | 1,033                                      | 6.2  | 1,975                       | 13.1 | 1,069                                      | 7.2  | 1,653                                    | 14.2 | 1,300                             | 21.1 |
| 45—49 .....                    | 400                                        | 2.1  | 896                         | 5.9  | 433                                        | 2.6  | 863                         | 5.7  | 499                                        | 3.4  | 697                                      | 6.0  | 621                               | 10.1 |
| 50—54 .....                    | 133                                        | 0.7  | 354                         | 2.3  | 140                                        | 0.8  | 329                         | 2.2  | 169                                        | 1.1  | 278                                      | 2.4  | 204                               | 3.3  |
| 55—59 .....                    | 45                                         | 0.2  | 130                         | 0.9  | 40                                         | 0.2  | 111                         | 0.7  | 55                                         | 0.4  | 90                                       | 0.8  | 61                                | 1.0  |
| 60+ .....                      | 12                                         | 0.1  | 42                          | 0.2  | 10                                         | 0.1  | 34                          | 0.2  | 16                                         | 0.1  | 24                                       | 0.2  | 17                                | 0.3  |
| Total .....                    | 19,514                                     |      | 15,150                      |      | 16,743                                     |      | 15,152                      |      | 14,842                                     |      | 11,649                                   |      | 6,153                             |      |
| Weight landed<br>'000 cwt. ... | 122.3                                      |      | 139.9                       |      | 111.4                                      |      | 140.1                       |      | 104.0                                      |      | 108.3                                    |      | 70.4                              |      |
| '000 Hours<br>fishing ....     | 255.8                                      |      | 304.4                       |      | 245.7                                      |      | 272.7                       |      | 227.2                                      |      | 244.7                                    |      | 132.1                             |      |

conditions, to market demands for plaice of a particular size, and to differences in age composition in the North Sea plaice stock.

The results are probably biased by insufficient randomization of the samples. Owing to the location of the laboratory at some distance from Esbjerg, it was necessary to collect material periodically. Each period of observation covered 5 or 6 days. There were 5 periods of observation (April—September).

E. URSIN

### English Landings of Plaice in 1955 and 1956

(Tables 18—19)

The routine sampling of the plaice landings at Lowestoft and Grimsby was continued during 1956. Table 18 shows the total number of fish landed in each 5 cm. length group at each port by English North Sea trawlers, and by English seiners at Grimsby during the biological year April 1956 to March 1957, with the figures for 1954—55 and

1955—56 for comparison. The length distribution of English seine landings at Grimsby are given for the first time and, compared with trawl landings, show a greater catch per unit fishing time and also a greater proportion of larger fish in the catch.

As in previous years the length composition of the Lowestoft landings has been converted into an age composition by means of an age/length key obtained from otolith samples. The age distribution expressed as the number of fish caught per 100 hours, with similar figures for the last two years, for comparison, are shown in Table 19. The 1951 year-class appears to be below average strength while the three strong year-classes of 1945—47 can still be seen.

J. A. GULLAND, T. WILLIAMS

Table 19. Number of fish of each age caught by Lowestoft trawlers per 100 hours fishing

| Length        | Age | II  | III  | IV   | V    | VI  | VII  | VIII | IX  | X   | XI | XII+ | Total |
|---------------|-----|-----|------|------|------|-----|------|------|-----|-----|----|------|-------|
| 1954—55 ..... |     | 162 | 911  | 2394 | 1532 | 759 | 1041 | 374  | 209 | 83  | 43 | 119  | 7,627 |
| 1955—56 ..... |     | 80  | 1261 | 952  | 1860 | 866 | 600  | 659  | 244 | 125 | 55 | 114  | 6,815 |
| 1956—57 ..... |     | 150 | 1035 | 2223 | 610  | 968 | 430  | 395  | 363 | 155 | 76 | 128  | 6,533 |

# Plaice and other Flatfish in the Skagerak-Kattegat Area

(Tables 20-22)

## 1. Coastal investigations on the 0 and I groups

(Table 20)

Fishing for 0-group plaice with a Johansen young-plaice trawl was carried out in July—August under favourable weather conditions. In the Skagerak the number of 0-group plaice caught per hour was about 7 times as large as the mean for the 14 years in which investigations have been carried out in the region during the last 30 years. Even larger numbers were found in the western Limfjord, up to 2394 per hour at one station, but as quantitative fishing has only been carried out there for a few years, a mean cannot be given for comparison.

In the northern Kattegat the number of 0-group plaice caught per hour was about double the normal; in the central Kattegat it was about two-thirds of the mean for the last 20 years. On the Danish coasts of the southern Kattegat the catch was 11 per hour, which is a little below the mean.

As regards the southern Kattegat coast of Sweden, the "Havkatten" was allowed to work inshore in Skelderviken and Laholm Bay, as in some previous years, because Sweden was not herself undertaking research of this kind in these waters. The mean of 56 0-group plaice found there is about a third of the normal catch in the area.

The numbers of I-group plaice were comparatively low in the Skagerak, but very high in the northern Kattegat. There were about 3 times as many 0-group fish as in 1955. It was stated in the Ann. Biol. XII, p. 96, that during the work in 1955 the weather was very unfavourable, and the numbers of 0-group plaice caught must therefore have been less than the actual numbers present. Nevertheless the I-group fish found here in 1956 seem to be so numerous that we may presume the occurrence of an immigration of young plaice from the Skagerak since the 1955 work was done. In the central and

southern Kattegat the average number of I-group plaice was about a quarter of the normal but in the southern Kattegat it was a little higher (5 per hour), which was about double the normal. Not very much significance can be attributed to such comparatively small deviations from the normal when the density of the stock is so low. The figure for the southern Kattegat is very small in view of the large number of 0-group fish found in 1955, but the movement from coastal waters must vary very much from one year to another. In Skelderviken and Laholm Bay the average number of I-group plaice was 26, which accords with the finding of a rich 0-group there in 1955.

The number of 0-group flounder caught per hour in the central Kattegat was 0.5, against the normal of about 1. None were found on other parts of the Danish coasts of the Skagerak or Kattegat and on the Swedish coast of the southern Kattegat the catch was only 5 per hour, which was about one-sixteenth of that obtained in 1955.

The number of I-group flounder was comparatively large in the northern and central Kattegat and on the Swedish coast of the southern Kattegat.

The numbers of 0-group turbot were very small, as is mostly the case; a few were found on the Skagerak and central Kattegat coasts. On the other hand, there were relatively many I-group turbot on the coasts of the Skagerak and northern and central Kattegat, which corresponds to the finding of comparatively large numbers of 0-group turbot in 1955.

A relatively large number of 0-group brill was found on the Danish coasts of the central and southern Kattegat, 4 and 2 fish per hour, respectively.

Extraordinarily large numbers of 0-group sole were found in Skelderviken and Laholm Bay—58 fish per hour, which is, on the average, about the same density as that of 0-group plaice.

On the Danish Kattegat coasts about 0.5 soles were caught per hour.

Table 20. Numbers of 0- and I-group plaice and 0-group flounder, turbot, and sole caught per hour with the Johansen young-plaice trawl in the Limfjord, on the Danish coasts of Skagerak and Kattegat, and on the Swedish coast of the southern Kattegat in 1956

| Locality                          | Month     | Number of stations |                   |                   |                     |                   |                 |
|-----------------------------------|-----------|--------------------|-------------------|-------------------|---------------------|-------------------|-----------------|
|                                   |           |                    | Plaice<br>0-group | Plaice<br>I-group | Flounder<br>0-group | Turbot<br>0-group | Sole<br>0-group |
| Nissum Broad-Limfjord .....       | July      | 12                 | 438               | 60                | 0.0                 | 0.0               | 0.0             |
| Skagerak .....                    | July      | 28                 | 179               | 7                 | 0.0                 | 0.2               | 0.0             |
| N. Kattegat .....                 | July      | 15                 | 176               | 131               | 0.0                 | 0.0               | 0.5             |
| C. Kattegat .....                 | July      | 18                 | 11                | 3                 | 0.5                 | 0.7               | 0.2             |
| S. Kattegat (Danish coasts) ..... | July-Aug. | 17                 | 10                | 5                 | 0.0                 | 0.0               | 0.6             |
| Skelderviken-Laholm Bay .....     | August    | 12                 | 56                | 26                | 5                   | 0.0               | 58              |



Table 21. Number of plaice caught per hour with the standard trawl in the northern Kattegat in 1956

| Depth zone,<br>m. | Number<br>of<br>stations | Age-groups |     |     |    |     | Length groups, cm. |       |       |       |       |       |       |     | Total |
|-------------------|--------------------------|------------|-----|-----|----|-----|--------------------|-------|-------|-------|-------|-------|-------|-----|-------|
|                   |                          | I          | II  | III | IV | V   | 11-15              | 16-20 | 21-25 | 26-30 | 31-35 | 36-40 | 41-45 |     |       |
| June              |                          |            |     |     |    |     |                    |       |       |       |       |       |       |     |       |
| 6-14 .....        | 4                        | 97         | 184 | 32  | 3  | 0.5 | 52                 | 208   | 64    | 13    | —     | —     | —     | 316 |       |
| 15-24 .....       | 6                        | 13         | 41  | 15  | 5  | 0.3 | 3                  | 34    | 29    | 8     | 0.3   | —     | —     | 74  |       |
| 25-34 .....       | 2                        | 8          | 19  | 9   | 3  | —   | 5                  | 11    | 18    | 5     | —     | —     | —     | 39  |       |
| November          |                          |            |     |     |    |     |                    |       |       |       |       |       |       |     |       |
| 11-14 .....       | 1                        | —          | 4   | 4   | —  | —   | —                  | —     | 6     | —     | —     | —     | 2     | 8   |       |
| 15-24 .....       | 4                        | 6          | 26  | 35  | 3  | —   | —                  | 1     | 24    | 26    | 15    | 4     | —     | 70  |       |
| 25-34 .....       | 5                        | 0.4        | 15  | 6   | —  | —   | —                  | 2     | 14    | 2     | 0.4   | 2     | —     | 20  |       |
| 35-54 .....       | 4                        | —          | 0.5 | —   | —  | —   | —                  | —     | —     | 0.5   | —     | —     | —     | 0.5 |       |

## 2. Quantitative fishing on the stock of plaice in Skagerak and Kattegat (Table 21)

In the northernmost Kattegat the plaice stock at 6—15 m. depth was dense. The fish were mainly 16—20 cm. long and most were of the II-group (1954 year-class). Also III-group fish were relatively numerous, corresponding to the predominance of this year-class in November 1955 at 10—34 m. depth. Most plaice of this year-class were a little below the size-limit in June, but they were heavily fished in autumn 1956. Age analyses showed the presence in almost equal numbers, of the II- and III-groups in the 15—34 m. depth zone and in November 1956 there were almost as many fish of length 21—25 cm. as of 26—30 cm.

In November only one haul was made at depths over 15 m. but the strong 1955 year-class, the I group, and most of the II-group found in June must still be present in the shallow water, and the

prospects for the fishery in 1957 and 1958 are good.

In the central Kattegat too few hauls were made for the stock to be estimated; such quantitative hauls as were made in the central Kattegat were made only in depths over 20 m. The stock in those waters was a little more dense than in 1955, with lengths between about 20 and 35 cm.

## 3. Commercial catches of plaice in the Skagerak and Kattegat (Table 22)

Figures for some of the 52 samples of plaice from Skagen, in the Skagerak, and the Kattegat are shown in Table 22. In the Skagerak to the north of Skagen, most of the plaice caught were 30—35 cm. long. Growth in the Skagerak is somewhat faster than in the northern Kattegat and the fishery is a little less intensive. The plaice are therefore able to reach a greater length here than to the south

Table 22. Length distribution and average length of plaice in commercial catches from the Skagerak and Kattegat in 1956  
S = Danish Seine; T = Trawl

|                               | Number<br>of<br>catches | Depth,<br>m. | Gear | Centimetre groups |       |       |       |       |       | Mean<br>length,<br>mm. |
|-------------------------------|-------------------------|--------------|------|-------------------|-------|-------|-------|-------|-------|------------------------|
|                               |                         |              |      | 26-27             | 28-30 | 31-35 | 36-40 | 41-45 | 46-50 |                        |
| Skagerak, N. of Skagen        |                         |              |      |                   |       |       |       |       |       |                        |
| 1952, November .....          | 1                       | 28           | S    | 22                | 31    | 34    | 13    | —     | —     | 311                    |
| 1956, November .....          | 3                       | 19-21        | S    | 8                 | 26    | 49    | 14    | 2     | —     | 330                    |
| S. of Skagen Reef             |                         |              |      |                   |       |       |       |       |       |                        |
| 1952, November .....          | 3                       | 9-15         | S    | 40                | 42    | 14    | 4     | —     | —     | 286                    |
| 1956, November .....          | 2                       | 11-13        | S    | 64                | 22    | 10    | 4     | —     | —     | 285                    |
| Ca. 15 miles S.S.E. of Hals   |                         |              |      |                   |       |       |       |       |       |                        |
| 1955, July, August .....      | 5                       | 9-13         | S    | 20                | 45    | 32    | 3     | —     | —     | 306                    |
| 1956, July, August .....      | 4                       | 12-14        | S, T | 14                | 34    | 47    | 5     | —     | —     | 312                    |
| N. of Djursland (Aalborg Bay) |                         |              |      |                   |       |       |       |       |       |                        |
| 1955, November .....          | 1                       | 13           | S    | 32                | 50    | 11    | 7     | —     | —     | 305                    |
| 1956, October, November ..    | 2                       | 11-17        | S    | 16                | 41    | 34    | 7     | 1     | —     | 312                    |
| E. of Grenå                   |                         |              |      |                   |       |       |       |       |       |                        |
| 1955, June .....              | 3                       | 20-25        | S, T | 4                 | 24    | 53    | 20    | —     | —     | 334                    |
| 1956, June, July .....        | 3                       | 19-24        | S, T | 6                 | 28    | 55    | 11    | —     | —     | 323                    |
| S. of Grenå                   |                         |              |      |                   |       |       |       |       |       |                        |
| 1955, September .....         | 1                       | 20           | S    | 4                 | 26    | 49    | 19    | 2     | —     | 330                    |
| 1956, September .....         | 1                       | 17           | S    | 7                 | 23    | 59    | 11    | —     | —     | 325                    |
| S. of Anholt                  |                         |              |      |                   |       |       |       |       |       |                        |
| 1955, November .....          | 1                       | 33           | T    | 2                 | 13    | 49    | 29    | 7     | —     | 344                    |
| 1956, September, November     | 2                       | 27-30        | T    | 11                | 23    | 38    | 22    | 5     | 1     | 337                    |



of Skagen, where the fishery is very heavy; very few plaice in the catches south of Skagen were more than 30 cm. long, as is very often the case.

Table 22 enables the 1956 catches of Skagen to be compared with the 1952 catches; no catches made in this season in the intervening years have been examined. In November 1952 the mean length of fish caught north of Skagen was very low, as a result of the entry into the stock of several good broods, especially that of 1950.

In the shallow water, 10—15 m. deep, in the central Kattegat the mean length of the plaice was about 0.5 cm. more than that in 1955; the plaice of the rich 1952 year-class, which predominated in the 1955 catches, although even by then their numbers had fallen, still constituted a large part of the catches in 1956 and had grown a little in the interval.

In the southern Kattegat the average length of the fish present in summer and autumn 1956 was mostly about  $1\frac{1}{2}$ —1 cm. less than in 1955, because by that time the rich 1952 year-class on those grounds had nearly been fished out and recruitment from the good 1955 year-class had begun.

AA. J. C. JENSEN

### Transplantation of Plaice to the Limfjord

It was intended to transplant 196,000 kg. of plaice from Nissum Broad to the inner broads of the Limfjord system in 1956, but adverse weather conditions made it impossible, and only 168,000 kg. were transplanted.

The work was carried out in April and May, and finished on 14. May, by which time the temperature in the water had risen to 11°C.

136,000 kg., corresponding to 1,810,000 fish, were transplanted to Thisted Broad and 32,000 kg., corresponding to 426,000 fish, were transplanted to the Løgstør-Hannæs Broads. All transportation was by well-smack.

Examination of average length, weight, and age composition of the plaice gave almost the same results as those for 1955. The figures for 1956, together with those for 1953, 1954, and 1955, are as follows:—

| Year | Average     |            | Age composition (%) |          |           |
|------|-------------|------------|---------------------|----------|-----------|
|      | length, cm. | weight, g. | I-group             | II-group | III-group |
| 1956 | 19          | 75         | 3                   | 82       | 15        |
| 1955 | 19          | 76         | 0                   | 85—88    | 15—12     |
| 1954 | 19.5        | 72         | 0                   | 85       | 14        |
| 1953 | 22.1        | 110        | 0                   | 14       | 85        |

A total of 2,420 plaice were tagged in the Limfjord, 500 with the Petersen disk, 1,300 with roll-tags, and 420 were tattooed and tagged with subcutaneous tags.

As in 1955, the percentage recapture of transplanted plaice in Thisted Broad shows a distinct decrease with increasing sea temperature (cf. Ann. Biol., XII, p. 100).

The cost of the transplantation to Thisted Broad in 1956 was equivalent to the value of 33 tons of marketable plaice. According to the fishery statistics, however, 80 tons had been caught by the end of 1956, corresponding to a percentage recapture (by weight) of 59% (26% in 1955).

A tagging experiment carried out in Thisted Broad in autumn 1955 showed that a large part of the relatively high catch in 1956 was formed of plaice transplanted in 1955.

The results of the transplantation to the Løgstør-Hannæs Broads cannot be estimated, because very few marked plaice were recaptured. It seems likely that the value of the catch has not balanced the cost of the operation.

O. BAGGE, E. BERTELSEN

### Dab

#### Kattegat and Limfjord

The number of dabs obtained per 1 hour's fishing with the cod trawl from the S/S "Biologen" is recorded in the following table (the number of hauls is in brackets):—

|                         | 1956     | 1955 |
|-------------------------|----------|------|
| N. Kattegat             | 244 (20) | 184  |
| C. Kattegat             | 174 (1)  | 71   |
| S. Kattegat             | 274 (9)  | 42   |
| Nissum Broad (Limfjord) | 8 (7)    | 8    |

It is evident that in 1956 the stock of dabs in the Kattegat was somewhat larger than in 1955. The stock in Nissum Broad was of the same size in the two years, although still much below that of previous years. In the remaining parts of the Limfjord only few dabs were obtained.

The size and age of the dabs obtained do not differ from those of previous years, I- and II-group fish being predominant and forming 80—90% of the catches.

J. KNUDSEN

Table 23. Numbers (000's) of soles in each cm. group landed at Lowestoft 1955, 1956, and Grimsby 1956 by English trawlers fishing in the North Sea

| Length, cm.           | Lowestoft<br>1955 | Lowestoft<br>1956 | Grimsby<br>1956 |
|-----------------------|-------------------|-------------------|-----------------|
| 20 .....              | 0.1               | —                 | —               |
| 1 .....               | 0.3               | 0.9               | 0.2             |
| 2 .....               | 1.6               | 3.7               | 0.6             |
| 3 .....               | 14.1              | 21.5              | 5.5             |
| 4 .....               | 34.9              | 59.0              | 30.4            |
| 5 .....               | 82.2              | 105.6             | 70.3            |
| 6 .....               | 115.3             | 135.2             | 80.8            |
| 7 .....               | 164.3             | 155.4             | 118.3           |
| 8 .....               | 202.4             | 182.9             | 153.6           |
| 9 .....               | 255.9             | 186.1             | 201.7           |
| 30 .....              | 258.8             | 196.3             | 222.2           |
| 1 .....               | 251.6             | 183.6             | 257.0           |
| 2 .....               | 215.3             | 154.3             | 273.7           |
| 3 .....               | 180.7             | 122.0             | 272.8           |
| 4 .....               | 141.9             | 105.7             | 196.7           |
| 5 .....               | 119.1             | 85.5              | 171.2           |
| 6 .....               | 95.1              | 65.9              | 145.7           |
| 7 .....               | 73.6              | 49.0              | 129.0           |
| 8 .....               | 53.0              | 34.8              | 68.3            |
| 9 .....               | 36.6              | 25.8              | 59.4            |
| 40 .....              | 24.2              | 17.9              | 36.5            |
| 1 .....               | 18.2              | 13.3              | 23.7            |
| 2 .....               | 11.6              | 8.9               | 12.2            |
| 3 .....               | 7.9               | 6.2               | 11.5            |
| 4 .....               | 4.9               | 3.6               | 4.9             |
| 5 .....               | 2.7               | 2.3               | 2.9             |
| 6 .....               | 1.3               | 1.2               | 2.2             |
| 7 .....               | 0.9               | 0.6               | 1.0             |
| 8 .....               | 0.4               | 0.4               | 1.6             |
| 9 .....               | 0.4               | 0.1               | —               |
| 50+ .....             | —                 | —                 | 0.1             |
| Total .....           | 2,369.3           | 1,927.7           | 2,554.0         |
| Wt. landed (cwt.) ... | 13,985            | 10,595            | 17,013          |

### English Market Measurements on Soles and Whiting (Tables 23-24)

During 1956 the routine sampling of the sole and whiting landings at Lowestoft was continued and in addition a regular programme of sole measuring was commenced at Grimsby.

Table 23 shows the numbers (in thousands) of soles in each cm. group landed at Lowestoft and Grimsby for the North Sea in 1956 with the Lowestoft figures for 1955 for comparison. The fish

Table 24. Landings of whiting at Lowestoft by British trawlers fishing in the North Sea in 1955 and 1956, giving the numbers (in thousands) and percentage at each length

| Length, cm.           | 1955    |      | 1956    |      |
|-----------------------|---------|------|---------|------|
|                       | Numbers | %    | Numbers | %    |
| 20 .....              | —       | —    | —       | —    |
| 1 .....               | 1.1     | 0    | 0.8     | 0    |
| 2 .....               | 0.1     | 0    | 1.1     | 0    |
| 3 .....               | 14.1    | 0.3  | 3.3     | 0.1  |
| 4 .....               | 72.1    | 1.4  | 16.5    | 0.6  |
| 5 .....               | 236.4   | 4.7  | 44.4    | 1.6  |
| 6 .....               | 448.7   | 9.0  | 92.5    | 3.4  |
| 7 .....               | 540.4   | 10.8 | 149.5   | 5.4  |
| 8 .....               | 574.4   | 11.5 | 181.1   | 6.6  |
| 9 .....               | 586.8   | 11.8 | 234.5   | 8.5  |
| 30 .....              | 527.2   | 10.6 | 261.1   | 9.5  |
| 1 .....               | 469.7   | 9.4  | 268.7   | 9.8  |
| 2 .....               | 377.2   | 7.6  | 278.1   | 10.1 |
| 3 .....               | 286.7   | 5.8  | 256.0   | 9.3  |
| 4 .....               | 224.9   | 4.5  | 228.6   | 8.3  |
| 5 .....               | 166.9   | 3.3  | 195.6   | 7.1  |
| 6 .....               | 127.3   | 2.6  | 155.9   | 5.6  |
| 7 .....               | 88.1    | 1.8  | 111.3   | 4.0  |
| 8 .....               | 67.5    | 1.4  | 80.6    | 2.9  |
| 9 .....               | 52.9    | 1.1  | 64.1    | 2.3  |
| 40-44 .....           | 89.5    | 1.8  | 110.3   | 4.0  |
| 45-49 .....           | 24.2    | 0.5  | 18.0    | 0.6  |
| 50-54 .....           | 4.6     | 0.1  | 4.6     | 0.2  |
| 55-59 .....           | 0.3     | 0    | 0.7     | 0    |
| 60+ .....             | 0.1     | 0    | —       | —    |
| Total .....           | 4,981.1 |      | 2,757.5 |      |
| Wt. landed (cwt.) ... | 20,923  |      | 14,075  |      |

landed at Grimsby differ appreciably in size from those landed at Lowestoft; this can be attributed to the different areas of the North Sea that are fished by the vessels from the two ports.

In Table 24 are shown the landings of whiting at Lowestoft from the North Sea in 1955 and 1956 given in terms of numbers and also percentage in each cm. group up to 40 cm., and over 40 cm. in 5 cm. groups. In 1956 64% of the fish were over 30 cm. in length compared with only 40% in 1955. The decline in the numbers of the smallest fish landed, first observed in 1955 and attributed to the use of the larger mesh and increased minimum size, is again evident.

J. A. GULLAND, T. WILLIAMS

## Industrial Fisheries

## 1. Observations on protected fish present in the oil-herring landed by German cutters

The fishery on young herring for processing was carried out in 1956 by approximately the same numbers of craft as in 1955. The season did not open, however, until the middle of July, and it closed as early as the beginning of October, when fishing was no longer profitable. The areas fished were the Coffee Soil, Southern Mud Bank, North-Eastern Deep, and later south and south-eastward of a line from the Tail of the Dogger to Esbjerg. The total catch was only about half of that of 1955, owing to unfavourable conditions.

The oil-herring catches were landed in

|                 |      |
|-----------------|------|
| Cuxhaven . . .  | .57% |
| Bremerhaven . . | .38% |
| Hamburg-Altona  | 5%   |

The composition of the catch by weight was similar to that of former years:—

|                   |      |
|-------------------|------|
| Herring . . . .   | .80% |
| Sprat . . . . .   | 5%   |
| Whiting . . . .   | 7%   |
| Haddock . . . .   | 4%   |
| Various . . . . . | 3%   |

Of this 6.7% were fish of the species and size protected by the Fishery Convention. This exceeds the 1955 proportion by 4.4%. The increase is brought about by larger numbers of small whiting, haddock, and cod, the 1955 year-class being very rich.

## 2. Observations on fish landed by German shrimpers

The catches landed from the North Sea by German shrimpers were smaller than in the preceding year. This is presumably the result of the low temperatures in summer and autumn 1956.

## Landings of German shrimpers, North Sea (in tons)

|      | Total  | Shrimp for human consumption | Animals other than shrimp |
|------|--------|------------------------------|---------------------------|
| 1955 | 52,743 | 5413                         | 9820                      |
| 1956 | 38,170 | 5641                         | 5289                      |

In spite of the reduction in landings of annimals other than shrimp (including fish, star fish, crabs and others) the number of fish of the species and sizes protected under the Fishery Convention was not much less than in the previous year:—

## Protected fish in the shrimper landings (in millions)

|      | Plaice | Dab | Sole | Whiting              |
|------|--------|-----|------|----------------------|
| 1955 | 136    | 35  | 74   | several million fish |
| 1956 | 138    | 39  | 53   | 9                    |

There was a clear decline only in the numbers of soles, which amounted in 1954 to 87.5 million fish. The numbers of whiting increased both in the shrimper landings and in the oil-herring catches. The proportion by weight was 0.6% in the Niedersachsen shrimper landings and 0.8% in the landings in Schleswig-Holstein. It is thus not of great consequence to the total proportion of undersized fish, which was 3.7% (by weight) in 1956 as compared with 3.8% in 1955, exclusive of whiting. In only 3 of the 802 samples examined did the proportion by weight exceed 10%. These samples were from landings in 12 different places.

P. F. MEYER-WAARDEN

## Rare Fishes from Near Northern Seas

## Scotland

The following rare fishes were landed in Scotland from the North Sea and western waters in 1956:—  
*Scymnorhinus licha* (BONNATERRE)—I: Pentland Skerries, II.

*Squatina squatina* (L.)—6: Firth of Clyde, II; 35 to 40'E.xN. Aberdeen, V (2); Stormy Bank, VIII; off Macduff, IX; off Noup Head, XI.  
*Torpedo nobiliana* (BONAPARTE)—I: East of Shetland, IX.

*Trygon pastinaca* (L.)—2: N. of Scotland, VIII; off Macduff, XI.

*Acipenser sturio* L.—6: W. of Scotland, III, IV; off Lossiemouth, V, X; Pentland Skerries, X; off Montrose, X.

*Alosa alosa* (L.)—3: Minch, II; Moray Firth, VII; Mouth of River Dee, Aberdeen, VIII.

*Alosa finta* (CUVIER)—38: Moray Firth, off Macduff, I (3), II (13), III (8); Shetland, II; Aberdeenshire coast, II (3); N. Minch, II (2); Scurdy Ness to St. Abbs Head, II (4), III (2), XI, XII.

*Sardina pilchardus* (WALBAUM)—2: N. Minch, I.  
*Engraulis encrasicolus* (L.)—7: Buchan Deep, II (6); 55°12'N.—0°20'E., X.

*Scorpaenopsis saurus* (WALBAUM)—3: 59°14'N.—6°50'W., VIII; 20'N.N.W. Flugga, IX; North Uist, XII.

*Belone belone* (L.)—13: N. Minch, II (several); N.E. North Sea, IV (several); Shetland, III; salmon stomach River Tay, IV; east coast, VIII (2), IX (8), X.

*Lampris guttatus* (BRÜNNICH)—2: Loch Fyne, VI; Shetland, VII.

*Trachypterus arcticus* (BRÜNNICH)—I: Off Kin-  
naird Head, VI.

*Morone labrax* (L.)—4: Moray Firth, I, II, XII;  
Firth of Clyde, III.

*Brama raii* (BLOCH)—18: Isle of Skye, I; Aber-  
deenshire coast, I, II, X, XI (2), XII; N.W. Butt  
of Lewis, IX (2); Scottish east coast south of  
Aberdeen, X, XI, XII (4); Moray Firth, II,  
XII (2).

*Mullus surmeletus* L.—10: East coast grounds, I  
(2), VIII, XII (5); N.W. of Foula, Shetland,  
III; E. of Orkney, X.

*Spondyllosoma cantharus* (GMELIN)—4: Coastal  
waters from Macduff to Peterhead, XII.

*Thunnus thynnus* (L.)—1: Isle of Canna, VIII—a  
young fish of 59.5 cm.

*Mugil chelo* (CUVIER)—1: Loch Fyne, VI.

*Mola mola* (L.)—1: Loch Shell, Isle of Lewis, IX.

Fuller details of these fish will be given in a  
paper to be published in *The Scottish Naturalist*.

B. B. RAE, E. WILSON

## Germany

In 1956 the "Institut für Seefischerei der Bundes-  
forschungsanstalt für Fischerei", Hamburg, re-  
ceived the undermentioned rare fish from Near  
Northern Seas.

The capture of the Marbled Electric Ray is of  
special interest, being the fourth record of the  
species for the area.

(c = caught, d = delivered)

*Torpedo marmorata* RISSO 1810 c. 22. 10. 56,  
Bløden Ground vicinity 1 ♀, 52 cm.

*Raja spinicauda* JENSEN 1914 c. 4. 3. 56, 61°05'N.,  
2°32'W., 1 ♂, 125 cm.

*Dasyatis pastinaca* (LINNAEUS 1758) d. 20. 6. 56,  
Borkum Reef, 1 ♀, 117 cm.

*Myliobatis aquila* (LINNAEUS 1758) d. 13. 12. 56,  
English Channel, 1 ♀, 60 cm.

*Centrolophus niger* (GMELIN 1789) d. 6. 9. 56,  
Northern North Sea, probably Fladen Ground,  
1, 53 cm.

*Brama brama* (BONNATERRE 1789) d. 13. 10. 56,  
N.W.-Reef, Dogger Bank vicinity, 1, 56 cm.

G. KREFFT

The following species were landed from the  
North Sea at Bremerhaven fish market in 1956:—

1) *Alopias vulpes* GMELIN

22. 9. 56 North of Helgoland, female 372 cm.,  
114 kg. (gutté),

24. 9. 56 Silver Pit, male 403 cm., 185 kg.  
(gutté),

24. 9. 56 Dogger Bank, male 406 cm., 100 kg.  
(gutté),

2) *Brama rayi* (BLOCH 1791)

1. 11. 56 N. North Sea (Utsira), 2 specimens:  
54 cm.—1,840 g. and 55 cm.—2,020 g.

3. 11. 56 N. North Sea (58°55'N., 3°27'E.),  
1 specimen: 40 cm.—1,740 g.

A. KOTTHAUS

## Sweden

As in 1955 the catches of rare or occasional  
fishes during 1956 have been rather sparse.

*Morone labrax* (L.) pug-headed specimen. 7. 2. 1956,  
Kattegat, 25 fathoms.

*Sebastes marinus* (L.). 4. 1. 1956, north of Anholt,  
30 fathoms.

*Mugil chelo* (CUVIER). 28. 8. 1956 and 19. 9. 1956 at  
Onsala, Swedish west coast.

Two specimens of *Crepidula fornicata* (L.)  
were caught at Älgön in the Hakefjord.

O. NYBELIN



## Baltic-Belt Seas

### INTRODUCTION

Contributions have been received from:—

|                  |                   |
|------------------|-------------------|
| Denmark:         | Poland:           |
| O. BAGGE         | SLAWOMIR SADOWSKI |
| E. BERTELSEN     |                   |
| AA. J. C. JENSEN | Sweden:           |
| J. KNUDSEN       | N. JERLOV         |
| H. THOMSEN       | A. LINDQUIST      |
|                  | G. OTTERLIND      |
| Finland:         | S. SAHLIN         |
| SVANTE NORDSTRÖM | USSR:             |
| Germany:         | M. FEDOSOV        |
| R. KÄNDLER       | I. NIKOLAEV       |
| J. KREY          | I. Z. LEDER       |
| G. PRAHM         | N. M. PASTUKHOVA  |
| G. WÜST          | G. ZAITSEV        |

#### A. Environment

On account of the cold winter and the persistence of the ice cover water temperature was below normal in the first half of the year. The cold spring and summer accentuated this anomaly, with the result that surface temperatures were most often below normal in the second half of the year also.

Temperatures beneath the discontinuity layer in the Belt Sea were also mostly below normal, but in late summer and autumn positive anomalies occurred occasionally, when strong winds mixed the upper and lower water layers.

In the Baltic the low temperatures in winter and the strong winds during summer together produced an extraordinarily thick homothermal layer in the upper levels, with a temperature lower than in most years. The intermediate layer, which preserves the winter coldness throughout the summer, had very low temperatures; ZOLOTUKHIN reports that some negative values occurred in Riga Bay as late as June.

The surface salinity in the western Baltic was very low in March—April but elsewhere it fluctuated about the normal. According to NIKOLAEV the freshwater discharge was greater than normal. The salinity in the Belts and western Baltic was mostly about normal, except in late summer and autumn when it often fell below normal on account of strong winds which mixed the layers.

The difference in stratification through the Great and Little Belts are shown in the hydrographic sections presented by KÄNDLER.

The thermal stratification in the Baltic was studied by WÜST, who found that the Arcona Basin is the region of most intensive mixing in the whole Baltic.

The oxygen content of the water in the deep basins of the Baltic was on the whole lower than in 1955. No considerable renewal of the water took place as a result of inflow from the Kattegat (see G. ZAITSEV and M. FEDOSOV).

KREY's studies of the phosphorus regime show that production in the central Baltic was lower than the North Sea.

The amount of plankton in the central Baltic and Gulf of Riga in May was higher than usual. NIKOLAEV attributes this to the large freshwater discharge and the intensive mixing of the water by storms. He assumes that the subnormal state of the plankton observed later on was due to the presence of a very large population of young herring and sprat. In late summer and autumn the plankton was very abundant.

The results obtained from the Finnish-Swedish joint investigations in the Gulf of Bothnia have been reported on by A. LINDQUIST.

## B. The Fish

The eggs and larvae of fish have been studied by Germany. KÄNDLER reports that the spawning of winter-spawning fish was retarded by the cold, and that relatively few cod and plaice eggs were found, whereas the numbers of eggs of flounder and dab were nearly normal (except in March); in the western Baltic the number of sprat eggs was less than normal and mackerel eggs were very few. A very strong inflow of salt water took place in June, which brought huge quantities of *Aglantha digitalis* into the Belt Sea. Large numbers of anchovy eggs, besides dab eggs and larvae, were found north of Fyn.

The density of 0-group plaice on the coasts of the Belts and the western Baltic was higher than might be expected from the hydrographical conditions; as in 1955, the large numbers seem to be attributable to the numerous stock of spawning fish. Last year's investigations showed the 1955 year-class of flounder to be relatively large, and accordingly a great many I-group fish were found in 1956. The number of 0-group sole was above normal, though lower than in 1955.

The numbers of plaice just under the Danish size limit caught in the Belts with the standard trawl were the same as in 1955 and the prospects for the fishery in 1957 are still good. The stock of under-sized flounder in the northern part of the Belts has improved very much through the entry of fish of the rich 1955 year-class from the western Baltic.

The density of the dab stock in those parts of the area investigated by Denmark was lower than in 1955.

KÄNDLER comments on the results of the German fishing with the standard trawl. Plaice were taken in somewhat greater quantity than flounder but in very much smaller quantity than the dab even, if we disregard the youngest age-groups; those of the plaice and flounder are mostly found in shallower water than is normally fished with the standard trawl. Besides dab, cod and whiting were also found in large quantities.

The quantitative hauls made by Sweden in the southern Baltic yielded fewer flatfish than in 1955, especially flounder, and OTTERLIND suggests that the low temperatures may have affected the migrations. The stock of plaice in this region was large.

Denmark undertook transplantation of plaice on about the same extent as in 1955. The percentage recaptures of marked plaice were about as low as in previous years, and the value of the yield estimated from these transplantations is almost as unsatisfactory as in 1955.

The Danish forecast of the silver-eel fishery did not accord with the catch as shown by the fishery returns, but the collection of statistics was rearranged a few years ago; moreover, the cancellation by Denmark of the size limit for silver eels may be expected to have influenced the catches.

AA. J. C. JENSEN

## ENVIRONMENT

## Hydrography

**Danish Observations in the Belts, the Western Baltic, and at Christiansø**

(Tables 1-3)

The Belts were covered with ice from the beginning of February to the beginning of March. In fjords and protected fairways the formation of ice commenced at the end of January, and not until the beginning of April were the fairways free of ice.

Temperatures generally were below normal, apart from the late summer, when positive anomalies occurred at the bottom.

The salinity observations exhibited no conspicuous trend, except that low bottom salinities occurred locally at "Halsskov Rev" in August—September.

HELGE THOMSEN

**Table 1. Monthly means of salinity and temperature at surface and bottom at the lightvessel "Halsskov Rev" for a longer series of years, and deviations from these means**  
(From the Danish Meteorological Institute, Nautical Department)

| Month                | I    | II   | III  | IV   | V              | VI   | VII                  | VIII | IX   | X    | XI   | XII  |
|----------------------|------|------|------|------|----------------|------|----------------------|------|------|------|------|------|
| <b>Salinity</b>      |      |      |      |      | <b>Surface</b> |      |                      |      |      |      |      |      |
| Mean .....           | 16.8 | 14.8 | 13.4 | 13.9 | 13.0           | 14.3 | 13.9                 | 14.4 | 14.6 | 16.2 | 16.3 | 15.6 |
| Deviation 1956 ..... | 0.5  | —    | —    | 0.7  | 0.2            | —    | (-0.4) <sup>1)</sup> | 2.7  | -1.0 | 2.4  | -1.2 | 3.0  |
|                      |      |      |      |      | <b>Bottom</b>  |      |                      |      |      |      |      |      |
| Mean .....           | 21.9 | 21.7 | 24.5 | 27.6 | 29.7           | 30.3 | 29.4                 | 27.6 | 24.7 | 23.3 | 21.5 | 22.1 |
| Deviation 1956 ..... | —    | —    | —    | 1.4  | 0.8            | —    | (-2.7) <sup>1)</sup> | -3.2 | -4.8 | 0.2  | -2.7 | -2.3 |
| <b>Temperature</b>   |      |      |      |      | <b>Surface</b> |      |                      |      |      |      |      |      |
| Mean .....           | 2.4  | 2.0  | 2.4  | 4.5  | 8.9            | 12.7 | 15.7                 | 16.4 | 14.5 | 11.1 | 7.3  | 4.0  |
| Deviation 1956 ..... | -0.2 | —    | —    | -1.2 | -0.4           | —    | (1.1) <sup>1)</sup>  | -1.4 | -0.2 | 0.3  | -0.5 | 0.7  |
|                      |      |      |      |      | <b>Bottom</b>  |      |                      |      |      |      |      |      |
| Mean .....           | 3.9  | 3.4  | 3.4  | 4.3  | 5.7            | 7.1  | 9.1                  | 11.7 | 13.2 | 11.6 | 8.4  | 5.9  |
| Deviation 1956 ..... | —    | —    | —    | -0.2 | -0.2           | —    | (1.1) <sup>1)</sup>  | 1.2  | 0.4  | 0.1  | -0.4 | -1.0 |

<sup>1)</sup> 12.—31. only. The lightvessel was withdrawn from 12. February to 28. March (owing to ice) and from 18. June to 11. July.

**Table 2. Monthly means of salinity and temperature at surface and bottom at the lightvessel "Gedser Rev" for a series of years, and deviations from these means**  
(From the Danish Meteorological Institute, Nautical Department)

| Month                | I    | II   | III  | IV   | V              | VI   | VII  | VIII | IX   | X    | XI   | XII  |
|----------------------|------|------|------|------|----------------|------|------|------|------|------|------|------|
| <b>Salinity</b>      |      |      |      |      | <b>Surface</b> |      |      |      |      |      |      |      |
| Mean .....           | 12.1 | 11.4 | 10.2 | 9.7  | 8.8            | 9.1  | 9.1  | 9.7  | 9.8  | 10.2 | 11.9 | 11.9 |
| Deviation 1956 ..... | -0.1 | —    | —    | 0.4  | -0.1           | -1.0 | 0.7  | 1.6  | -0.4 | 2.9  | -1.7 | 0.7  |
|                      |      |      |      |      | <b>Bottom</b>  |      |      |      |      |      |      |      |
| Mean .....           | 14.3 | 13.7 | 15.0 | 14.7 | 14.9           | 15.6 | 14.4 | 14.1 | 13.8 | 13.6 | 12.6 | 13.8 |
| Deviation 1956 ..... | -0.4 | —    | —    | —    | 2.6            | 2.4  | 1.4  | -1.4 | -1.0 | 1.1  | -0.7 | 0.3  |
| <b>Temperature</b>   |      |      |      |      | <b>Surface</b> |      |      |      |      |      |      |      |
| Mean .....           | 2.2  | 1.5  | 2.1  | 4.1  | 8.0            | 12.6 | 15.8 | 16.1 | 14.3 | 11.1 | 7.6  | 4.3  |
| Deviation 1956 ..... | 0.6  | —    | —    | -1.6 | -0.7           | -1.2 | 1.2  | -0.7 | -0.8 | 0.9  | -0.3 | 0.4  |
|                      |      |      |      |      | <b>Bottom</b>  |      |      |      |      |      |      |      |
| Mean .....           | 3.0  | 2.4  | 2.3  | 3.4  | 5.8            | 9.2  | 12.3 | 13.9 | 13.8 | 11.8 | 8.1  | 5.1  |
| Deviation 1956 ..... | 0.1  | —    | —    | -0.9 | -1.8           | -3.1 | 0.9  | 1.3  | -0.4 | 0.6  | -0.1 | -0.1 |

**Table 3. Monthly means of salinity and temperature at Christiansø for a longer series of years, and deviations from these means**  
(From the Danish Meteorological Institute, Nautical Department)

| Month                | I    | II   | III  | IV   | V    | VI   | VII  | VIII | IX   | X    | XI   | XII  |
|----------------------|------|------|------|------|------|------|------|------|------|------|------|------|
| <b>Salinity</b>      |      |      |      |      |      |      |      |      |      |      |      |      |
| Mean .....           | 7.0  | 7.0  | 7.0  | 7.0  | 7.0  | 7.2  | 7.4  | 7.2  | 7.0  | 7.0  | 7.1  | 7.0  |
| Deviation 1956 ..... | 0.7  | 0.6  | 0.7  | 0.8  | 0.9  | 0.8  | 0.8  | 1.0  | 0.9  | 0.9  | 0.7  | 1.2  |
| <b>Temperature</b>   |      |      |      |      |      |      |      |      |      |      |      |      |
| Mean .....           | 3.3  | 2.1  | 1.8  | 3.0  | 6.1  | 11.0 | 15.2 | 16.0 | 14.1 | 11.1 | 8.1  | 5.5  |
| Deviation 1956 ..... | -0.6 | -1.7 | -1.9 | -1.9 | -1.9 | -0.1 | 0.1  | 0.8  | -1.2 | -0.6 | -0.8 | -0.2 |

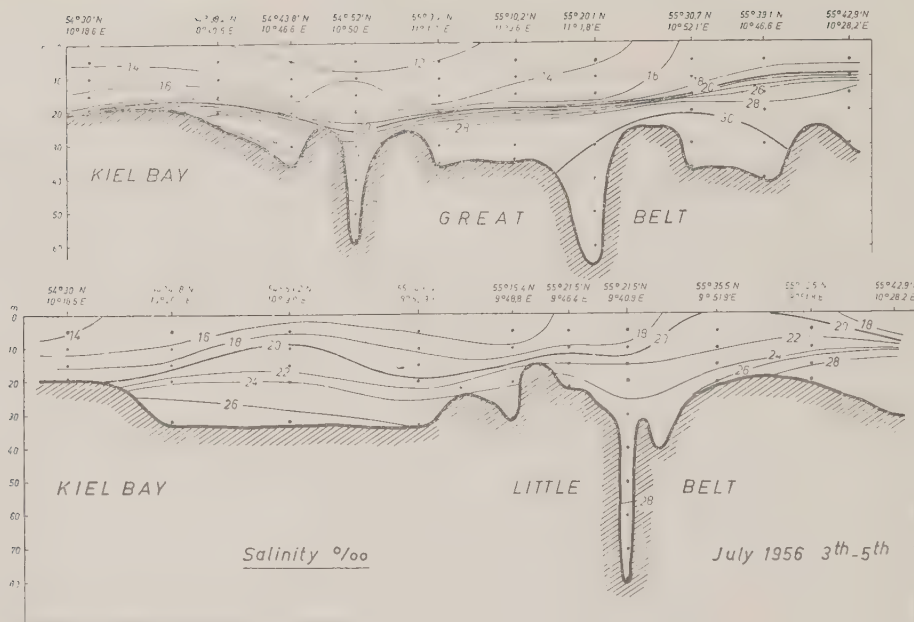


Figure 1. Longitudinal sections of temperature through the Great and Little Belts, 3.—5. July 1956.

## German Observations of the Hydrography of the Belts and the Baltic in 1956

### 1. Hydrography of the Belts and Western Baltic

(Figure 1)

To illustrate the salinity stratification in the Great and Little Belts, two longitudinal sections from "Kiel" lightship to Samsø are given in Figure 1. In the Great Belt the discontinuity between the upper layer of Baltic water and the bottom layer of Kattegat water is sharply marked, lying in a depth of about 20 m. In contrast, the stratification in the Little Belt is not so pronounced. The advance of the bottom water of high salinity from the Kattegat is stopped by the ridge near Assens. On the other hand, the surface salinity is higher than in the Great Belt, which indicates that the Little Belt is not in the path of the main currents flowing between the Baltic and the Kattegat.

R. KÄNDLER

### 2. Hydrographic conditions in the Western Baltic

(Table 4)

Daily surface observations (at 8<sup>h</sup> MET) of temperature and salinity were made by 3 German lightships in 1956:— "Flensburg" (54°50.3'N., 9°53.8'E.); "Kiel" (54°29.5'N., 10°17.3'E.); and "Fehmarnbelt" (54°36.0'N., 11°9.0'E.). In addition,

hydrographical observations at various depths were carried out once a day at the "Fehmarnbelt" lightship.

The observations made at the "Fehmarnbelt" are representative of regions in which both in-going and out-going currents occur, while the observations made at the "Flensburg" and "Kiel" are typical of the border zones of the western Baltic, away from strong currents.

The data will be published by Deutsches Hydrographisches Institut, Hamburg ("Beobachtungen auf den deutschen Feuerschiffen der Nord- und Ostsee im Jahre 1956". Meeresk. Beobacht. u. Ergebn., 9). Table 4 shows the monthly mean values of the surface and bottom observations. Figures in brackets are based on less than 15 separate daily observations.

Compared with the monthly means for surface and bottom over the period 1950/54, those for 1956 were in general normal or rather below; only the surface temperatures for January, July, and especially October were above the monthly means for 1950/54, and from July till October the bottom temperatures were also above the mean. In most months salinity values, at both surface and bottom, were also below the 1950/54 monthly means. Thus the yearly means for 1956 of temperature and



Table 4. Monthly means of temperature and salinity at surface and bottom, for the period 1950/54 and for 1956, at the German lightvessels "Flensburg", "Kiel", and "Fehmarnbelt"  
(From Deutsches Hydrographisches Institut, Hamburg)

| Month       |               | I            | II    | III     | IV    | V     | VI    | VII   | VIII  | IX    | X     | XI    | XII   |       |
|-------------|---------------|--------------|-------|---------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Salinity    |               | Surface      |       |         |       |       |       |       |       |       |       |       |       |       |
|             | "Flensburg"   | Mean 1950/54 | 19.78 | 18.31   | 17.45 | 17.41 | 14.80 | 15.22 | 16.87 | 17.65 | 18.82 | 19.21 | 18.39 | 19.88 |
|             |               | 1956         | 20.53 | (18.56) | 15.20 | 14.58 | 14.85 | 14.61 | 15.76 | 17.26 | 16.91 | 17.31 | 18.14 | 18.53 |
|             |               | Surface      |       |         |       |       |       |       |       |       |       |       |       |       |
|             | "Kiel"        | Mean 1950/54 | 19.25 | 17.89   | 17.14 | 16.45 | 13.85 | 13.57 | 14.83 | 15.73 | 16.53 | 18.67 | 18.65 | 19.53 |
|             |               | 1956         | 20.06 | (17.61) | 14.85 | 13.69 | 13.75 | 13.24 | 14.47 | 16.03 | 16.39 | 16.90 | —     | —     |
|             |               | Surface      |       |         |       |       |       |       |       |       |       |       |       |       |
|             | "Fehmarnbelt" | Mean 1950/54 | 15.44 | 13.50   | 13.52 | 12.98 | 10.33 | 11.73 | 13.17 | 12.11 | 15.36 | 14.78 | 14.53 | 16.38 |
|             |               | 1956         | 15.35 | (9.96)  | 10.10 | 12.19 | 11.81 | 10.32 | 11.63 | 14.20 | 11.82 | 16.75 | 13.12 | 16.37 |
|             |               | Bottom       |       |         |       |       |       |       |       |       |       |       |       |       |
|             |               | Mean 1950/54 | 21.23 | 21.08   | 21.95 | 24.54 | 26.50 | 27.70 | 28.51 | 27.02 | 25.40 | 22.73 | 21.24 | 21.62 |
|             |               | 1956         | 18.35 | (19.04) | 17.25 | 24.52 | 26.85 | 28.99 | 27.62 | 23.10 | 18.19 | 18.95 | 16.57 | 19.98 |
| Temperature |               | Surface      |       |         |       |       |       |       |       |       |       |       |       |       |
|             | "Flensburg"   | Mean 1950/54 | 2.9   | 1.2     | 1.9   | 4.9   | 10.5  | 14.1  | 15.5  | 16.3  | 14.4  | 11.5  | 7.9   | 5.3   |
|             |               | 1956         | 3.2   | (0.0)   | 0.3   | 3.4   | 8.9   | 13.7  | 16.2  | 14.7  | 14.4  | 12.3  | 7.6   | 4.9   |
|             |               | Surface      |       |         |       |       |       |       |       |       |       |       |       |       |
|             | "Kiel"        | Mean 1950/54 | 2.7   | 1.1     | 1.9   | 5.1   | 10.0  | 14.3  | 16.5  | 16.7  | 15.0  | 11.7  | 8.4   | 5.1   |
|             |               | 1956         | 3.2   | (0.4)   | 0.6   | 3.7   | 9.4   | 14.3  | 16.4  | 15.7  | 14.8  | 12.6  | —     | —     |
|             |               | Surface      |       |         |       |       |       |       |       |       |       |       |       |       |
|             | "Fehmarnbelt" | Mean 1950/54 | 2.9   | 1.3     | 2.0   | 5.3   | 9.4   | 14.2  | 16.4  | 16.7  | 15.1  | 11.7  | 8.4   | 5.3   |
|             |               | 1956         | 2.8   | (0.4)   | 0.4   | 3.3   | 8.6   | 12.9  | 15.9  | 15.6  | 14.4  | 12.2  | 7.7   | 5.2   |
|             |               | Bottom       |       |         |       |       |       |       |       |       |       |       |       |       |
|             |               | Mean 1950/54 | 4.2   | 2.4     | 2.8   | 4.0   | 5.3   | 7.0   | 9.0   | 10.5  | 12.6  | 11.9  | 9.7   | 6.2   |
|             |               | 1956         | 3.0   | (1.5)   | 0.6   | 3.3   | 5.1   | 6.4   | 6.8   | 10.7  | 13.6  | 12.2  | 8.3   | 5.5   |

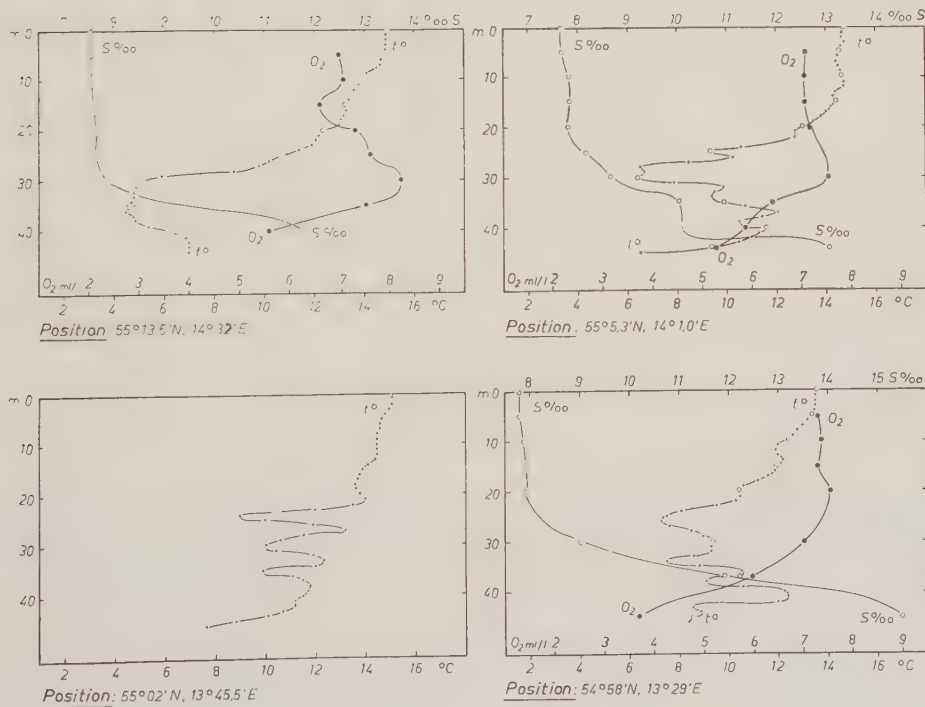


Figure 2. Salinity, temperature, and oxygen content at 4 stations in the Arcona Basin, 10. August 1956.  
Dotted part of curve = electrical temperature measurements at each metre.

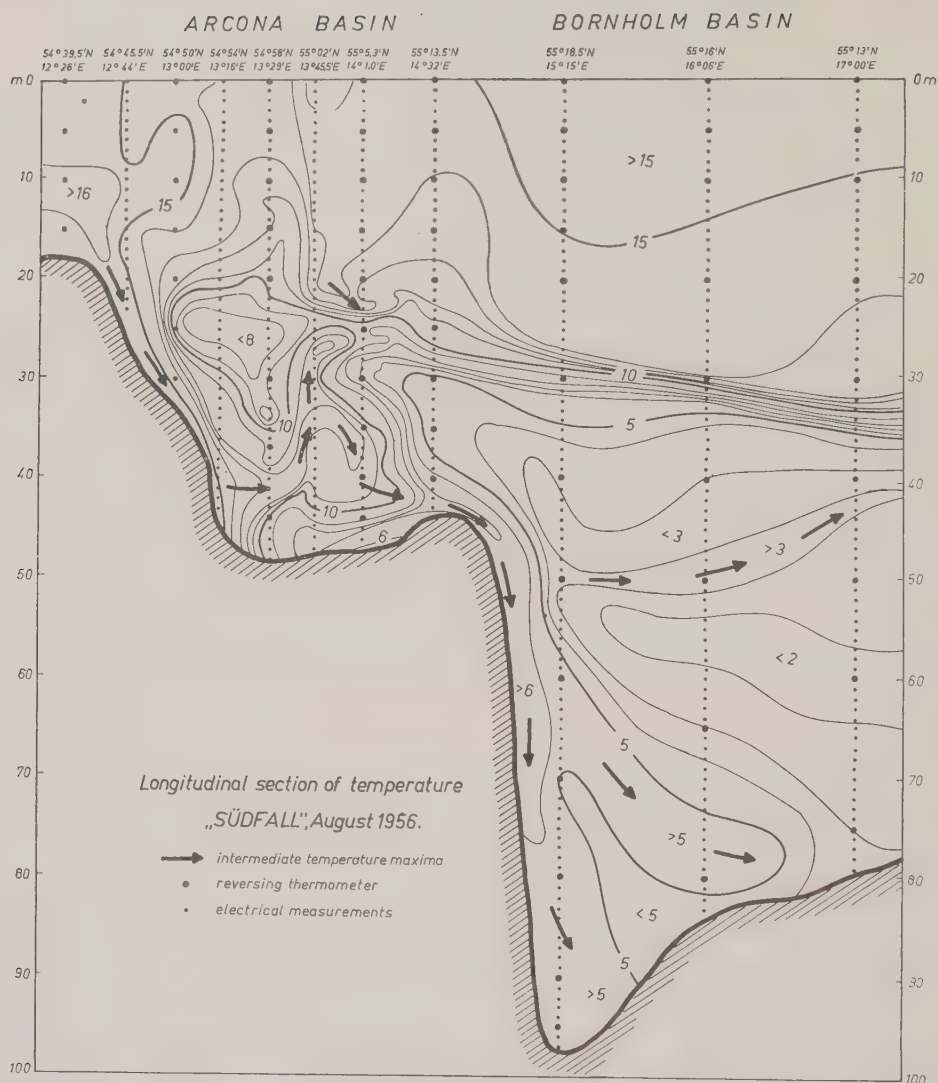


Figure 3. Longitudinal section of temperature through the Arcona and Bornholm Basins, 7.—11. August 1956. (Preliminary construction of isotherms.)

salinity at surface and bottom are lower than the yearly mean values for 1950/54:—

|               |         | 1950/54 |       | 1956 |       |
|---------------|---------|---------|-------|------|-------|
|               |         | t°C.    | S ‰   | t°C. | S ‰   |
| "Flensburg"   | surface | 8.9     | 17.81 | 8.3  | 16.83 |
| "Kiel"        | surface | 9.0     | 16.84 | —    | —     |
| "Fehmarnbelt" | surface | 9.1     | 13.65 | 8.3  | 12.80 |
| "Fehmarnbelt" | bottom  | 7.1     | 24.13 | 6.4  | 21.62 |

#### On the Thermal Micro-Stratification of the Baltic, with Especial Reference to the Layers of the Deep and Bottom Water

(Figures 2 and 3)

In the summer of 1956, observations on temperature, salinity, oxygen, and other factors affecting biological production were made with R/V "Süd-fall" at 27 stations along the deepest valley in the Baltic between Kiel and the entrance to the Gulf of Finland.

G. PRAHM

Table 5. Monthly means of salinity and temperature in 1956 at surface and bottom at Swedish lightships with the deviations from 30-year means

| Month                 | I              | II | III | IV    | V     | VI   | VII   | VIII  | IX   | X     | XI   | XII   |
|-----------------------|----------------|----|-----|-------|-------|------|-------|-------|------|-------|------|-------|
| <b>Salinity</b>       | <b>Surface</b> |    |     |       |       |      |       |       |      |       |      |       |
| "Sydostbrotten" ..... | —              | —  | —   | —     | —     | 4.65 | 4.03  | 4.26  | 4.18 | —     | 5.30 | —     |
|                       | —              | —  | —   | —     | —     | ±0   | -0.3  | ±0    | -0.4 | —     | +0.1 | —     |
| "Finngrundet" .....   | 5.68           | —  | —   | —     | —     | 5.29 | 5.43  | 5.55  | 5.51 | 5.55  | 5.70 | 5.77  |
|                       | +0.3           | —  | —   | —     | —     | +0.2 | ±0    | +0.3  | +0.3 | +0.2  | +0.3 | +0.4  |
| "Svenska Björn" ..... | 6.31           | —  | —   | —     | —     | 5.68 | 5.97  | 5.23  | 5.52 | 6.03  | 6.53 | 6.43  |
|                       | +0.1           | —  | —   | —     | —     | ±0   | +0.4  | -0.3  | -0.1 | +0.1  | +0.4 | -0.3  |
| "Falsterborev" .....  | 7.98           | —  | —   | 7.71  | 7.79  | 7.79 | 7.83  | 8.06  | 8.63 | 8.56  | 8.51 | 8.96  |
|                       | -0.2           | —  | —   | +0.2  | +0.3  | +0.3 | ±0    | +0.1  | +0.6 | +0.2  | +0.3 | +0.7  |
| "Oskarsgrundet" ..... | 14.22          | —  | —   | 13.78 | 9.65  | 8.16 | 9.79  | 11.17 | 9.47 | 12.48 | 8.85 | 12.07 |
|                       | +3.1           | —  | —   | +4.3  | +2.2  | -1.6 | -0.1  | +1.6  | -1.3 | +0.7  | -1.7 | +0.1  |
| Depth m.              | <b>Bottom</b>  |    |     |       |       |      |       |       |      |       |      |       |
| "Sydostbrotten" .. 40 | —              | —  | —   | —     | —     | 5.93 | 5.81  | —     | 6.09 | 6.07  | 5.96 | —     |
|                       | —              | —  | —   | —     | —     | +0.3 | +0.1  | —     | +0.5 | +0.5  | +0.4 | —     |
| "Finngrundet" ... 30  | 5.70           | —  | —   | —     | —     | 5.80 | 5.71  | 5.59  | 5.77 | 5.63  | 5.71 | 5.78  |
|                       | ±0             | —  | —   | —     | —     | +0.1 | +0.1  | -0.1  | ±0   | -0.1  | ±0   | ±0    |
| "Svenska Björn" . 40  | 6.62           | —  | —   | —     | —     | 7.00 | 7.23  | 7.04  | 7.37 | 6.98  | 6.91 | 7.07  |
|                       | -0.3           | —  | —   | —     | —     | -0.3 | ±0    | -0.7  | +0.1 | +0.3  | ±0   | +0.3  |
| "Falsterborev" ... 10 | 9.87           | —  | —   | 7.77  | 8.13  | 7.79 | 8.17  | 9.58  | 8.70 | 8.89  | 8.51 | 8.99  |
|                       | +1.4           | —  | —   | +0.2  | +0.6  | +0.1 | +0.1  | +1.4  | +0.5 | +0.2  | +0.2 | +0.5  |
| "Oskarsgrundet" . 8   | 15.57          | —  | —   | 14.56 | 10.49 | 8.54 | 10.45 | 12.07 | 9.50 | 16.04 | 9.11 | 12.68 |
|                       | +2.0           | —  | —   | +2.1  | +0.7  | -3.7 | -1.0  | +1.2  | -3.1 | +2.1  | -5.0 | +1.9  |
| <b>Temperature</b>    | <b>Surface</b> |    |     |       |       |      |       |       |      |       |      |       |
| "Sydostbrotten" ..... | —              | —  | —   | —     | —     | 8.3  | 14.6  | 14.5  | 9.5  | 6.1   | 1.8  | —     |
|                       | —              | —  | —   | —     | —     | -0.1 | +0.5  | -0.9  | -2.4 | -1.6  | -3.0 | —     |
| "Finngrundet" .....   | 0.7            | —  | —   | —     | —     | 7.6  | 13.2  | 14.2  | 10.4 | 7.2   | 3.7  | 2.0   |
|                       | -0.9           | —  | —   | —     | —     | +0.3 | -0.6  | -1.4  | -1.7 | -0.8  | -1.4 | -1.0  |
| "Svenska Björn" ..... | 1.4            | —  | —   | —     | —     | 7.9  | 13.8  | 14.7  | 12.1 | 7.8   | 4.5  | 2.5   |
|                       | -1.0           | —  | —   | —     | —     | -1.0 | -0.9  | -1.1  | -1.0 | -1.2  | -2.1 | -1.8  |
| "Falsterborev" .....  | 2.9            | —  | —   | 1.9   | 6.0   | 12.5 | 13.2  | 13.8  | 13.2 | 11.2  | 6.7  | 4.8   |
|                       | ±0             | —  | —   | -1.8  | -1.8  | +0.1 | -2.6  | -2.7  | -1.5 | -0.5  | -1.7 | -0.3  |
| "Oskarsgrundet" ....  | 2.7            | —  | —   | 2.4   | 6.9   | 12.9 | 14.5  | 14.5  | 13.6 | 11.1  | 6.8  | 4.9   |
|                       | -0.1           | —  | —   | -1.9  | -1.5  | -0.2 | -1.6  | -1.8  | -1.2 | -0.3  | -1.2 | +0.2  |
| Depth m.              | <b>Bottom</b>  |    |     |       |       |      |       |       |      |       |      |       |
| "Sydostbrotten" .. 40 | —              | —  | —   | —     | —     | 2.0  | 2.1   | 1.3   | 1.4  | 2.4   | 2.2  | —     |
|                       | —              | —  | —   | —     | —     | ±0   | -0.2  | -1.3  | -2.2 | -3.8  | -3.2 | —     |
| "Finngrundet" ... 30  | 1.0            | —  | —   | —     | —     | 2.1  | 3.2   | 2.0   | 3.5  | 5.3   | 3.9  | 2.1   |
|                       | -0.6           | —  | —   | —     | —     | -2.4 | -2.0  | -3.3  | -2.3 | -1.2  | -1.2 | -0.8  |
| "Svenska Björn" . 40  | 2.2            | —  | —   | —     | —     | 1.7  | 2.0   | 2.4   | 3.5  | 3.7   | 4.6  | 3.1   |
|                       | -0.5           | —  | —   | —     | —     | -1.5 | -1.8  | -2.9  | -2.1 | -2.6  | -1.5 | -1.5  |
| "Falsterborev" ... 10 | 2.9            | —  | —   | 1.8   | 5.8   | 11.0 | 12.6  | 13.4  | 13.2 | 11.3  | 6.8  | 4.7   |
|                       | ±0             | —  | —   | -1.8  | -1.7  | -0.8 | -2.0  | -2.3  | -1.4 | -0.4  | -1.6 | -0.4  |
| "Oskarsgrundet" . 8   | 3.0            | —  | —   | 2.6   | 6.6   | 12.6 | 14.3  | 14.6  | 13.7 | 11.4  | 7.2  | 5.1   |
|                       | -0.4           | —  | —   | -1.7  | -1.5  | +0.1 | -1.5  | -1.9  | -1.0 | -0.1  | -1.2 | -0.2  |

Returning from Helsinki to Kiel (4.—11. August 1956) we used an electrical thermometer — "Thermofühler"<sup>1)</sup> — at 18 stations in the eastern part of Gothland Basin, in Bornholm Basin, and in Arcona Basin, so that we can construct a complete longitudinal section of temperature, controlled in regard to depth by serial measurements.

The thermal stratification was characterized by the upper sharp thermocline, which was observed in the Gulf of Finland at 10—20 m. and going down to 30—35 m. in Bornholm Basin, and by the intermediate temperature maxima in the deep and bottom waterlayers. These temperature maxima

were situated in the eastern Gothland Basin some distance above the salinity discontinuity layer. The electric thermometer showed small inversions between 30 and 50 m., i. e., within the layer of cold winter water above the second thermocline down to the deep water of relatively high salinity. In Bornholm Basin, we found from 3 to 5 intermediate maxima; the most complicated thermal structure was observed in Arcona Basin (Fig. 2).

In the longitudinal section of temperature (Fig. 3) we perceive some interesting features. We see first that the Arcona Basin is the region of the most intensive mixing in the whole Baltic. This, it is suggested, depends on the weather conditions on both sides of the Darsser Schwelle with its shallow

<sup>1)</sup> This "Thermofühler" is described in Kieler Meeresforsch., 11: 5—7, 1955.

Table 6. Hydrographic observations from the deep basins of the Baltic

| West of Gothland 57°28'N., 17°41'E. |       |       |                | Gothland Deep 57°24'N., 20°16'E. |       |       |                |
|-------------------------------------|-------|-------|----------------|----------------------------------|-------|-------|----------------|
| 25. March                           |       |       |                | 26. March                        |       |       |                |
| m.                                  | °C.   | ‰     | O <sub>2</sub> | m.                               | °C.   | ‰     | O <sub>2</sub> |
| 0                                   | -0.11 | 7.31  | —              | 0                                | 0.27  | 7.77  | —              |
| 10                                  | -0.14 | 7.31  | 10.22          | 10                               | 0.24  | 7.76  | 10.22          |
| 60                                  | -0.12 | 7.34  | 10.15          | 40                               | 0.19  | 7.81  | 10.09          |
| 80                                  | 2.63  | 8.07  | 7.63           | 60                               | 0.27  | 7.83  | 10.08          |
| 100                                 | 4.79  | 10.64 | 1.09           | 70                               | 4.43  | 10.03 | 2.82           |
|                                     |       |       |                | 100                              | 5.01  | 11.20 | 1.60           |
|                                     |       |       |                | 220                              | 5.76  | 13.42 | 0.64           |
| 23. August                          |       |       |                | 24. August                       |       |       |                |
| m.                                  | °C.   | ‰     | O <sub>2</sub> | m.                               | °C.   | ‰     | O <sub>2</sub> |
| 0                                   | 15.62 | 6.72  | —              | 0                                | 14.60 | 7.17  | —              |
| 10                                  | 15.07 | 6.68  | 7.04           | 10                               | 14.60 | 7.15  | 7.02           |
| 30                                  | 2.56  | 7.49  | 9.02           | 20                               | 14.59 | 7.17  | —              |
| 50                                  | 1.82  | 7.76  | 8.80           | 30                               | 3.01  | 7.80  | 9.30           |
| 60                                  | 3.00  | 8.60  | 5.45           | 60                               | 1.43  | 7.93  | 8.90           |
| 70                                  | 4.60  | 10.19 | 1.66           | 70                               | 2.50  | 8.85  | 5.65           |
| 105                                 | 4.78  | 10.83 | 0.46           | 80                               | 4.39  | 10.20 | 2.22           |
|                                     |       |       |                | 100                              | 4.94  | 11.14 | 1.39           |
|                                     |       |       |                | 210                              | 5.76  | 13.34 | 0.25           |

| Bornholm Deep 55°18.7'N., 15°15'E. |       |       |                | Landsort Deep 58°35'N., 18°15'E. |       |       |                |
|------------------------------------|-------|-------|----------------|----------------------------------|-------|-------|----------------|
| 27. March                          |       |       |                | 26. March                        |       |       |                |
| m.                                 | °C.   | ‰     | O <sub>2</sub> | m.                               | °C.   | ‰     | O <sub>2</sub> |
| 0                                  | 0.16  | 7.52  | —              | 0                                | -0.21 | 7.17  | —              |
| 10                                 | 0.09  | 7.50  | 10.50          | 10                               | -0.24 | 7.17  | 10.36          |
| 20                                 | -0.11 | 7.58  | 10.40          | 40                               | -0.19 | 7.47  | 9.95           |
| 40                                 | -0.04 | 7.72  | 10.17          | 60                               | 1.37  | 7.73  | 9.02           |
| 60                                 | 0.20  | 11.08 | 9.57           | 80                               | 4.18  | 9.30  | 3.89           |
| 70                                 | 6.40  | 14.97 | 3.28           | 100                              | 4.62  | 10.31 | 1.99           |
| 100                                | 6.52  | 16.28 | 0.38           | 200                              | 5.08  | 11.34 | 1.10           |
| 26. August                         |       |       |                | 24. August                       |       |       |                |
| m.                                 | °C.   | ‰     | O <sub>2</sub> | m.                               | °C.   | ‰     | O <sub>2</sub> |
| 0                                  | 14.51 | 7.66  | —              | 0                                | 15.62 | 6.29  | —              |
| 10                                 | 14.46 | 7.66  | 7.09           | 10                               | 15.49 | 6.29  | 7.42           |
| 30                                 | 14.39 | 7.66  | 6.92           | 30                               | 2.04  | 7.42  | 9.31           |
| 40                                 | 5.56  | 7.77  | —              | 50                               | 1.40  | 7.71  | 9.24           |
| 50                                 | 2.81  | 7.95  | 8.92           | 70                               | 3.10  | 9.12  | 4.70           |
| 60                                 | 3.89  | 11.23 | 7.04           | 80                               | 4.19  | 10.08 | 2.36           |
| 80                                 | 5.40  | 15.46 | 1.68           | 100                              | 4.69  | 10.73 | 1.23           |
|                                    |       |       |                | 150                              | 5.04  | 11.31 | 1.00           |
|                                    |       |       |                | 300                              | 5.14  | 11.45 | 0.84           |
|                                    |       |       |                | 425                              | 5.10  | 11.49 | 0.71           |

saddle depth of only 18 m. As a result of the inflows on different occasions we find considerable irregularity in the courses of the isotherms and great spatial variation of temperature. Here in certain months, under appropriate conditions the different water masses are formed which enter as the bottom current and apparently also as the deep or intermediate current according to their density. We see in August 1956 three incursions of relatively warm water into Bornholm Basin. The arrows which indicate these incursions do not represent continuous deep and bottom currents, but only occasional movements of these warmer water masses.

A full discussion of the data will be published in "Kieler Meeresforschungen", 13, 1957.

G. WÜST

### Swedish Observations

(Tables 5 and 6)

Throughout 1956 temperatures at all levels in the Baltic were below normal, with few exceptions. The greatest negative anomaly was 3.8°, which occurred near bottom at "Sydostbotten" in October.

The salinity varies little on the whole. At the beginning of January and April water of fairly high salinity prevailed in the Sound, whereas minimum salinity occurred in June.

Data collected in March and August from the deep basins of the Baltic give no clear indication of any inflow of salt water. Oxygen values for a

position west of Gothland on 25. March were somewhat higher than those found in March 1955. The consumption of oxygen in the deep water from March to August is clearly demonstrated.

N. JERLOV

### Finnish Observations

#### Three Sections in the Gulf of Bothnia

(Figures 4—11)

In the summer and autumn of 1956 three sections in the Gulf of Bothnia were investigated by Sweden and Finland in cooperation. These sections are presented in Figures 4—11. The isohalines have been drawn according to the salinities determined in the samples taken at standard depths, the iso-

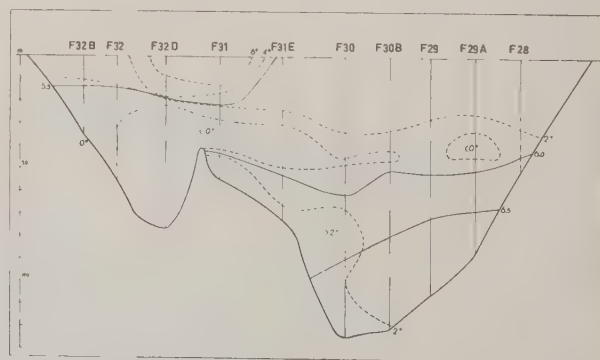


Figure 4. Southern section, 5.—6. June 1956.



therms are based on bathythermograms as well as on the temperatures obtained with reversing thermometers.

The stations investigated in these sections were:—

## Southern section

|      | N.                    | E.                    |
|------|-----------------------|-----------------------|
| F28  | 61°08'                | 20°55 $\frac{1}{2}$ ' |
| F29A | 61°05 $\frac{1}{2}$ ' | 20°36'                |
| F29  | 61°03'                | 20°16'                |
| F30B | 61°04'                | 19°55 $\frac{1}{2}$ ' |
| F30  | 61°05'                | 19°34 $\frac{1}{2}$ ' |
| F31E | 61°08'                | 19°06'                |
| F31  | 61°11'                | 18°37'                |
| F32D | 61°11 $\frac{1}{2}$ ' | 18°14'                |
| F32  | 61°12'                | 17°51'                |
| F32B | 61°12 $\frac{1}{2}$ ' | 17°28'                |

## Central section

|       | N.     | E.                    |
|-------|--------|-----------------------|
| F26F  | 62°12' | 17°38 $\frac{1}{2}$ ' |
| F26G  | 62°06' | 17°51 $\frac{1}{2}$ ' |
| F26H  | 62°08' | 18°10'                |
| F26I  | 62°08' | 18°34'                |
| F26J  | 62°01' | 18°54'                |
| F26K  | 61°55' | 19°06'                |
| F26L  | 61°50' | 19°35'                |
| F26M  | 61°50' | 20°06'                |
| F26N  | 61°50' | 20°36'                |
| F26NS | 61°44' | 20°32'                |
| F26P  | 61°43' | 21°00'                |
| F26PS | 61°40' | 21°00'                |
| F26Q  | 61°38' | 21°20'                |

## Northern Section

## Finnish Stations

|      | N.       | E.       |
|------|----------|----------|
| F20A | 62°36'   | 20°50'   |
| F21  | 62°36'   | 20°35'   |
| F22  | 62°36'   | 20°01'   |
| F23  | 62°39'   | 19°31'   |
| F23B | 62°45'   | 19°11.5' |
| F24  | 62°51.5' | 18°52'   |
| F25A | 63°00'   | 18°46'   |

## Swedish Stations

|       | N.     | E.     |
|-------|--------|--------|
| 1 ... | 63°00' | 20°40' |
| 2 ... | 63°00' | 20°10' |
| 3 ... | 63°00' | 19°40' |
| 4 ... | 63°00' | 19°10' |
| 5 ... | 63°00' | 18°46' |

SVANTE G. NORDSTRÖM

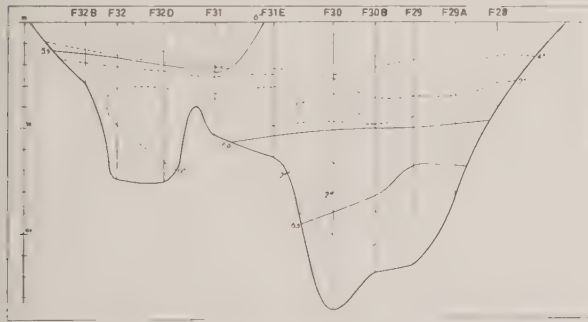


Figure 5. Southern section, 14.-15. June 1956.

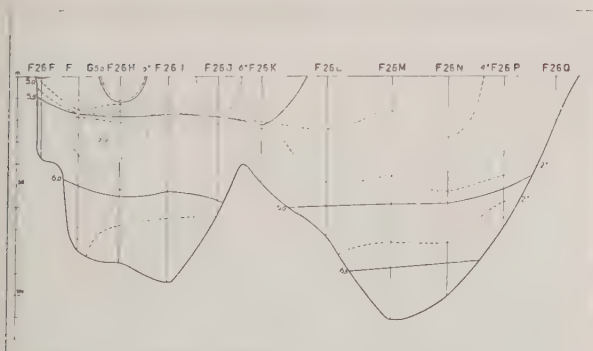


Figure 6. Central section, 7. June 1956.

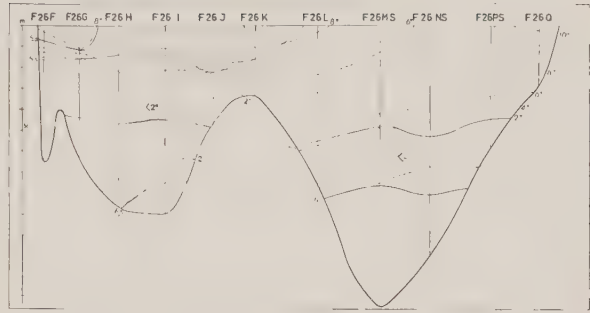


Figure 7. Central section, 20.-21. June 1956.

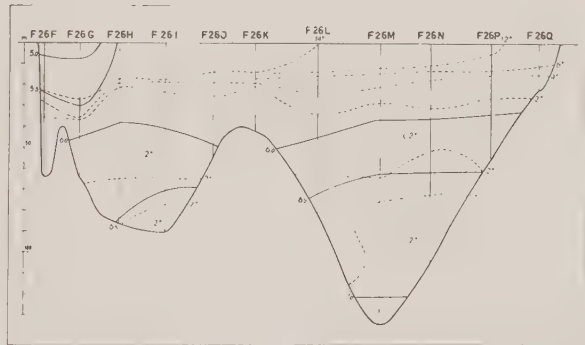


Figure 8. Central section, 13.-14. August 1956.

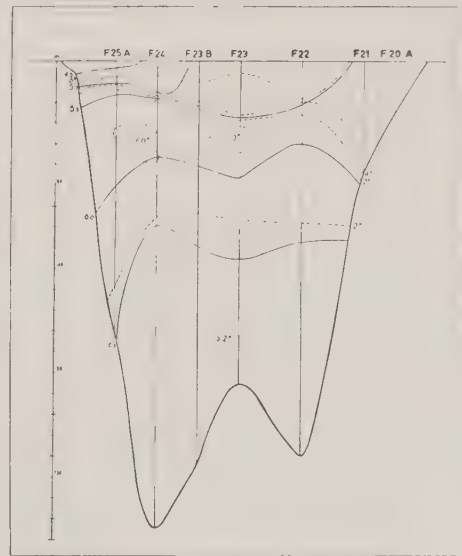


Figure 9. Northern section, 8. June 1956.

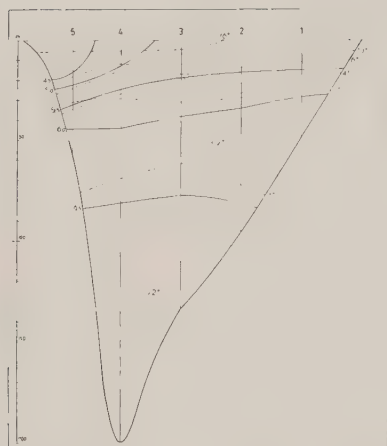


Figure 10. Northern section, 12. July 1956.

### Soviet Observations

#### 1. Distribution of Water Temperature, Salinity, and Oxygen Content in the Baltic from May to December 1956

##### Temperature

By the middle of May the temperature of the upper water layer, 20—25 m. thick, in the central regions of the Baltic (the Gothland Deep) had reached 2°—2.5°C., while in the open regions south of Gothland Deep the same temperature was observed at 40 m. At depths from 40 to 60 or 70 m. lower temperatures approaching the winter value of 1°—1.5° prevailed. The temperature increased with depth and at depths greater than 100—200 m. a more or less constant temperature of the order of 5°—6° was observed.

In the last 10 days of May the surface water temperature in the northern and central parts of the Gulf of Riga reached 7°—8°, though that in the southern part was considerably lower, ranging from 3°—4° near the surface and from 0.2° to 0.3° near the bottom.

In June the temperature of the surface layer in the central Baltic rose to 7°—8°. In the middle of June the surface temperature in the western part of the Gulf of Finland and the Gulf of Riga reached 11°—13°; by that time negative values of temperature had almost disappeared from near the bottom of the Gulf of Riga.

The warming of the upper layer was considerably faster in June than during July and the first half of August. During the latter period the temperature of the surface layer 10—15 m. thick was raised by only 3°—4°, due to the coolness of the weather.

In the middle of August the temperature of the surface layer in the northern and central parts of

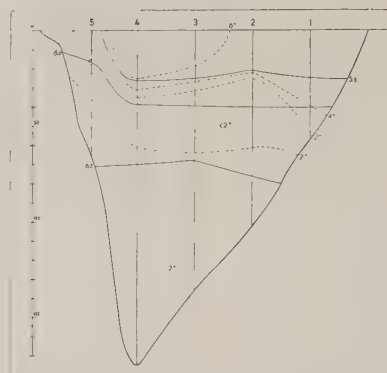


Figure 11. Northern section, 22. October 1956.

the Baltic and near the Gdansk and Bornholm Deep reached its highest value of 15°—15.5°; the value for the open parts of the Gulf of Riga was about 15°—16°.

In May and August 1956 the temperature in both the open part of the sea and inside the bays fell short of the mean value by 1.5°—2°C. (that for May being 4.5°—5.5° for the open sea and 7°—9° in the bays; and for August 17°—17.5° for the open sea and 17°—18° in the bays). In August the thickness of the homothermal layer in the northern and central Baltic and in the Gulf of Riga reached 18—20 m.; in the Gulf of Gdansk it attained 30—35 m. The thickness of the thermocline at that time was about 4—5 m. in the open sea and 3—6 m. in the Gulf of Riga. It may be noted that in the deep water regions the negative anomalies of temperature in the intermediate cold layer remained up to the end of the summer. Thus in the vicinity of Gothland Deep the temperature at a depth of 50—60 m. was 1°—1.5° lower than the mean value; it was for instance 0.5—0.6° lower than the temperatures observed at the same depths in August 1926, 1929, and 1940, which were preceded by severe or very severe winters.

By the end of October the temperature of the upper layer down to 15—20 m. in the central Baltic had fallen to 9°—10° and in the Gulf of Riga to 6°—9°. To about mid-November the temperature of this layer in the southern Baltic was 6°—9° and still lower close inshore. In autumn the temperature of the layer from 20 to 60—70 m. rose considerably (by 4°—5°). At depths greater than 70—80 m. the temperature distribution was approximately the same as in May—August.

From the end of October to the middle of November the homothermal layer was fairly thick. It was about 40—50 m. thick in the northern and central Baltic and in the Gulf of Riga and ap-

proached 60—70 m. in the vicinity of Bornholm Deep and to the westward.

Observations made during the first 10 days of December along the section from the Island of Gothland to Ventspils showed that temperature of the surface layer in the central Baltic was  $5^{\circ}$  in the open sea and  $2^{\circ}$ — $2.5^{\circ}$  in coastal waters. The temperature in the middle and western parts of the Gulf of Finland did not exceed  $3^{\circ}$ — $4^{\circ}$ .

Due to the intensive mixing produced by the wind in summer and autumn the homothermal layer reached 60 m. depth in December in the central Baltic and 80 m. in the Gulf of Riga.

We may summarize the foregoing statements as follows: —

1. The main feature of the temperature conditions in the regions under investigation is a moderate warming of the upper layers of the sea in the spring and summer and the retention of comparatively low temperatures in the intermediate layer until autumn.

2. In spring, summer, and autumn the temperature of the water at 60—70 m. depth was  $1.5^{\circ}$ — $2.5^{\circ}$  below the long-period mean.

3. The anomalies observed in 1956 are attributable to the severe winter of 1955—56 and the cool summer.

#### Salinity and oxygen content

The observations of salinity and dissolved oxygen in the Baltic indicate (provisionally) that in 1956 there was no considerable inflow of salt water from the North Sea. Although the salinity of the bottom layers in the deep basins remained rather high in comparison with the long-period means, it was nevertheless somewhat lower than in the two or three years previous. Thus in Gothland Deep the salinity of the bottom layer (215—225 m.) was  $13.51^{0}_{00}$  in May,  $13.38^{0}_{00}$  in August, and  $13.42^{0}_{00}$  in October. The average annual salinity in 1956 was  $13.44^{0}_{00}$ ; in 1953,  $13.79^{0}_{00}$ ; in 1954,  $13.53^{0}_{00}$ , and in 1955,  $13.51^{0}_{00}$ . The average salinity for 1956 was  $1.17^{0}_{00}$  higher than the average of  $12.27^{0}_{00}$  computed by I. M. SOSKIN for the 53-year period 1902 to 1954.

This feature was most pronounced in Bornholm Deep, where the salinity at 80 m. was  $18.53^{0}_{00}$  in 1953,  $17.60^{0}_{00}$  in 1954,  $16.95^{0}_{00}$  in 1955, and  $15.82^{0}_{00}$  in 1956. Thus the salinity here was  $0.09^{0}_{00}$  lower than the long-period average of  $15.91^{0}_{00}$ , as computed by SOSKIN. The annual mean was  $13.48^{0}_{00}$  in 1954,  $13.03^{0}_{00}$  in 1955, and  $11.74^{0}_{00}$  in 1956.

The hypothesis that no strong inflow of North Sea water occurred in 1956 is also confirmed by

the data on the oxygen content of the deep water in the Gothland Basin. The oxygen content near the bottom in 1955 was 1.36 ml./l. on the average, corresponding to a saturation of 16%; it decreased sharply in 1956 to 0.07 ml./l. (1% saturation) in summer but rose again in autumn to 0.22 ml./l. (3%).

A sharp fall in the oxygen content of the bottom layer is characteristic not only of Gothland Deep but of other parts of the Baltic also. For example, on a meridional section along the deep trench with depths from 140 to 160 m., which crosses the central and northern Baltic, the oxygen content near the bottom was between 0.1 and 0.5 ml./l. in summer (1—4%) and between 0.2 and 0.6 ml./l. (2—7%) in autumn. At 80 or 90 m. the oxygen content varied from 1.0 to 2.5 ml./l. in summer and 1.5 to 3.0 ml./l. in autumn. It may be noted that the vertical distribution of dissolved oxygen shows little variety throughout the basin of the northern and central Baltic where the depth exceeds 80 m. From the surface to 35 or 40 m. the oxygen content was about 6.8—7.2 ml./l. in summer, and 7.2—7.6 ml./l. in autumn; below this depth, at 60—70 m. it increased to 8.8—9.2 ml./l. in summer and to 8.0—8.6 ml./l. in autumn, and at still greater depths a sharp increase was observed. The oxygen content varied with depth near the bottom between 1.0 and 2.5 ml./l. in summer and between 1.5 and 4.0 ml./l. in autumn (at depths down to 150 m.), and between 0.1 and 0.5 ml./l. in summer and from 0.2 to 0.6 ml./l. in autumn (at depths down to 225 m.). In shallow coastal regions with depths not exceeding 60 m. the oxygen content near the bottom was practically the same as that at the surface, ranging from 6.5 to 8.0 ml./l. in summer and from 7.0 to 7.4 ml./l. in autumn.

The valuation at the surface did not exceed 103%.

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## 2. Mixing of Water Masses in 1955 and 1956

(Tables 7 and 8)

Comparison of the temperature and salinity data for 1955—1956 with data for previous years enables the following conclusions to be drawn.

#### Thermal regime

In spite of the mild winter of 1954—55 in the central and northern Baltic, the temperatures of the surface layers in spring 1955 were lower than those measured in 1932—1939. However, in summer 1955 the water became unusually warm. In early September the surface temperature in Gothland Deep reached  $18.89^{\circ}\text{C}$ . which is second only to the temperature reached in July 1927. It



Table 7. Hydrographical observations in the Northern Deep (59°01'N., 21°05'E.)

| 3. II. 1955          |        |                                |                |                                | 2. VI. 1955  |                                |                |                  | 10. IX. 1955  |                                |                |                                |                |                  |    |                  |
|----------------------|--------|--------------------------------|----------------|--------------------------------|--------------|--------------------------------|----------------|------------------|---------------|--------------------------------|----------------|--------------------------------|----------------|------------------|----|------------------|
| Depth in m.          | °C.    | S <sup>0</sup> / <sub>00</sub> | O <sub>2</sub> | O <sub>2</sub>                 | °C.          | S <sup>0</sup> / <sub>00</sub> | O <sub>2</sub> | O <sub>2</sub>   | °C.           | S <sup>0</sup> / <sub>00</sub> | O <sub>2</sub> | O <sub>2</sub>                 |                |                  |    |                  |
|                      |        |                                | %              | cm. <sup>3</sup>               |              |                                | %              | cm. <sup>3</sup> |               |                                | %              | cm. <sup>3</sup>               | %              | cm. <sup>3</sup> |    |                  |
| 0 .....              | 2.96   | 7.34                           | 87             | 7.88                           | 7.14         | 6.93                           | 112            | 9.23             | 18.18         | 6.64                           | 115            | 6.58                           |                |                  |    |                  |
| 10 .....             | —      | —                              | —              | —                              | 6.17         | 6.98                           | —              | —                | 17.98         | 6.64                           | —              | —                              |                |                  |    |                  |
| 20 .....             | 3.12   | 7.43                           | 80             | 7.26                           | 5.10         | 6.98                           | 104            | 8.92             | 15.91         | 6.64                           | 117            | 6.83                           |                |                  |    |                  |
| 30 .....             | 3.10   | 7.45                           | 85             | 7.68                           | 2.28         | 7.25                           | 99             | 9.19             | 6.79          | 7.09                           | —              | —                              |                |                  |    |                  |
| 40 .....             | 3.08   | 7.50                           | 86             | 7.82                           | 2.24         | 7.43                           | 96             | 8.89             | 3.75          | 7.52                           | —              | —                              |                |                  |    |                  |
| 50 .....             | —      | —                              | —              | —                              | 2.20         | 7.76                           | 95             | 8.72             | —             | —                              | —              | —                              |                |                  |    |                  |
| 60 .....             | 3.14   | 7.47                           | 36             | 3.27                           | —            | —                              | —              | —                | 2.68          | 7.94                           | —              | 10.04                          |                |                  |    |                  |
| 70 .....             | —      | —                              | —              | —                              | 4.64         | 10.14                          | 27             | 2.29             | —             | —                              | —              | —                              |                |                  |    |                  |
| 80 .....             | 3.20   | 7.54                           | 12             | 1.05                           | —            | —                              | —              | —                | 4.21          | 10.44                          | 21             | 8.68                           |                |                  |    |                  |
| 100 .....            | 5.18   | 10.64                          | 92             | 7.65                           | 5.10         | 11.28                          | 15             | 1.32             | 5.15          | 11.58                          | 26             | 8.40                           |                |                  |    |                  |
| 150 .....            | 5.22   | 11.58                          | 17             | 1.42                           | 5.22         | 11.89                          | 18             | 1.47             | 5.23          | 11.83                          | 13             | 8.39                           |                |                  |    |                  |
| Bottom .....         | 5.22   | 11.58                          | —              | —                              | 5.29         | 11.82                          | 18             | 1.52             | —             | —                              | —              | —                              |                |                  |    |                  |
|                      | 170 m. |                                |                |                                | 164 m.       |                                |                |                  | 140 m.        |                                |                |                                |                |                  |    |                  |
| % of North Sea water | 19.3   |                                |                |                                | 25.0         |                                |                |                  | 24.6          |                                |                |                                |                |                  |    |                  |
| 25. X. 1955          |        |                                |                |                                | 14. VI. 1956 |                                |                |                  | 3. VIII. 1956 |                                |                |                                | 24. X. 1956    |                  |    |                  |
| Depth in m.          | °C.    | S <sup>0</sup> / <sub>00</sub> | °C.            | S <sup>0</sup> / <sub>00</sub> | °C.          | S <sup>0</sup> / <sub>00</sub> | O <sub>2</sub> | O <sub>2</sub>   | °C.           | S <sup>0</sup> / <sub>00</sub> | °C.            | S <sup>0</sup> / <sub>00</sub> | O <sub>2</sub> | O <sub>2</sub>   |    |                  |
|                      |        |                                |                |                                |              |                                | %              | cm. <sup>3</sup> |               |                                |                |                                | %              | cm. <sup>3</sup> | %  | cm. <sup>3</sup> |
| 0 .....              | 8.62   | 6.85                           | 11.18          | 6.97                           | 15.62        | 6.92                           | 96             | 6.61             | 8.64          | 7.01                           | 93             | 7.37                           | 8.64           | 7.01             | 93 | 7.37             |
| 10 .....             | 8.62   | 6.86                           | 10.88          | 6.97                           | 15.42        | 6.92                           | 96             | 6.64             | 8.50          | 7.01                           | —              | —                              | 8.50           | 7.01             | —  | —                |
| 20 .....             | 8.58   | 6.86                           | 2.07           | 7.35                           | 15.40        | 7.01                           | 96             | 6.59             | 8.46          | 7.01                           | 95             | 7.57                           | 8.46           | 7.01             | 95 | 7.57             |
| 30 .....             | 8.53   | 6.86                           | —              | —                              | 2.18         | 7.53                           | 101            | 9.31             | 8.38          | 7.03                           | —              | —                              | 8.38           | 7.03             | —  | —                |
| 40 .....             | 8.52   | 6.86                           | —              | —                              | 2.06         | 7.62                           | 95             | 8.79             | 8.32          | 7.06                           | 94             | 7.54                           | 8.32           | 7.06             | 94 | 7.54             |
| 50 .....             | 3.04   | 8.04                           | 0.92           | 7.79                           | —            | —                              | —              | —                | 3.82          | 7.77                           | —              | —                              | 3.82           | 7.77             | —  | —                |
| 60 .....             | 3.34   | 8.71                           | —              | —                              | 1.36         | 7.95                           | 85             | 8.00             | 2.75          | 7.93                           | 87             | 7.90                           | 2.75           | 7.93             | 87 | 7.90             |
| 70 .....             | —      | —                              | —              | —                              | —            | —                              | —              | —                | —             | —                              | —              | —                              | —              | —                | —  | —                |
| 80 .....             | 4.54   | 10.53                          | —              | —                              | 4.16         | 10.22                          | 23             | 2.00             | 4.50          | 10.73                          | 14             | 1.21                           | 4.50           | 10.73            | 14 | 1.21             |
| 100 .....            | 5.06   | 4.49                           | 4.85           | 11.16                          | 4.75         | 10.94                          | 14             | 1.15             | 4.50          | 10.73                          | 14             | 1.21                           | 4.50           | 10.73            | 14 | 1.21             |
| 150 .....            | 5.20   | 11.88                          | 4.95           | 11.29                          | 5.08         | 11.61                          | 8              | 0.66             | 5.10          | 11.52                          | 8              | 0.63                           | 5.10           | 11.52            | 8  | 0.63             |
| Bottom .....         | —      | —                              | —              | —                              | —            | —                              | —              | —                | —             | —                              | —              | —                              | —              | —                | —  | —                |
|                      | 133 m. |                                |                |                                | 120 m.       |                                |                |                  | 160 m.        |                                |                |                                | 160 m.         |                  |    |                  |
| % of North Sea water | 25.1   |                                |                |                                | 23.7         |                                |                |                  | 23.4          |                                |                |                                | 22.6           |                  |    |                  |

should be noted that the average July temperature for the period 1926—1935 and 1939 is only 16.35°.

Due to the very severe conditions in winter 1955—56, cooling was so pronounced that in mid-May the surface temperature was lower than in February 1955, and the temperature of the cold intermediate layer fell to an unprecedented level. Even in August, at 60 m. in Gothland Deep, the exceedingly low temperature of 1.18° was encountered. Only once before had the temperature at this depth fallen below 2° (14. July 1929, 1.93°). Similarly low values were recorded in the Northern Deep (Station F-74).

In June 1956 the temperature of the cold intermediate layer fell to the unusually low minimum of 0.9°C.; in August it was 1.36°. Observations in previous years indicated only two such minima: 1.9° on 13. July 1929 and 1.45° on 11. July 1932. In every other year the temperature remained above 2°.

The temperature distribution in autumn 1956 differed only slightly from that in 1955; at 60 m.

depth the temperature in October 1956 was 0.6° lower than in 1955.

#### Salinity

In the central Baltic the 1954—55 winter was marked by a powerful influx of North Sea water. On 5. February 1955 the salinity at 80 m. in Gothland Deep rose above 11 ‰ for the first time; that of the bottom layers was 13.59 ‰, i.e., only 0.6 ‰ below the highest value ever observed in this area (13.65 ‰ on 6. August 1954). No more notable inflows were encountered in the area thereafter, and in 1955—56 the mean salinity in Gothland Deep fell gradually. New water entered the Northern Deep later, and was observed there in June 1955, which is quite normal. Thereafter until the end of 1956 slow dilution occurred though on a rather more extensive scale than in Gothland Deep.

JACOBSEN's method for estimating the relative proportions of the various types of water in the Norwegian, Greenland, and Barents Seas was used by us to assess the proportions of Baltic and North Sea water present. Baltic water was taken to be of



Table 8. Hydrographical observations in the Gothland Deep (57°22'N., 19°57'E.)

| 5. II. 1955          |      |                                |                     |                                    | 31. V. 1955 |                                |                     |                                    |  | 9. IX. 1955   |                                |                     |                                    |  |
|----------------------|------|--------------------------------|---------------------|------------------------------------|-------------|--------------------------------|---------------------|------------------------------------|--|---------------|--------------------------------|---------------------|------------------------------------|--|
| Depth in m.          | °C.  | S <sup>0</sup> / <sub>00</sub> | O <sub>2</sub><br>% | O <sub>2</sub><br>cm. <sup>3</sup> | °C.         | S <sup>0</sup> / <sub>00</sub> | O <sub>2</sub><br>% | O <sub>2</sub><br>cm. <sup>3</sup> |  | °C.           | S <sup>0</sup> / <sub>00</sub> | O <sub>2</sub><br>% | O <sub>2</sub><br>cm. <sup>3</sup> |  |
| 0                    | 2.98 | 7.90                           | 85                  | 7.65                               | 5.78        | 7.86                           | 110                 | 9.21                               |  | 18.89         | 7.11                           | 105                 | 6.44                               |  |
| 10                   | —    | —                              | —                   | —                                  | —           | —                              | —                   | —                                  |  | 18.74         | 7.11                           | —                   | —                                  |  |
| 20                   | 2.98 | 7.94                           | 85                  | 7.70                               | 4.40        | 7.86                           | 103                 | 9.04                               |  | 13.22         | 7.25                           | 100                 | 7.20                               |  |
| 30                   | —    | —                              | —                   | —                                  | —           | —                              | 103                 | 9.05                               |  | 5.52          | 7.47                           | —                   | —                                  |  |
| 40                   | 3.00 | 7.99                           | 85                  | 7.70                               | 4.28        | 7.86                           | 105                 | 9.19                               |  | 4.21          | 7.83                           | —                   | —                                  |  |
| 50                   | —    | —                              | —                   | —                                  | —           | —                              | —                   | —                                  |  | —             | —                              | —                   | —                                  |  |
| 60                   | 3.29 | 8.26                           | 80                  | 7.23                               | 3.03        | 7.90                           | 97                  | 8.61                               |  | 2.60          | 8.01                           | 85                  | 9.04                               |  |
| 80                   | 5.13 | 11.78                          | 23                  | 1.97                               | 4.68        | 10.50                          | 28                  | 2.41                               |  | 4.66          | —                              | —                   | —                                  |  |
| 100                  | 5.44 | 12.48                          | 25                  | 2.11                               | 5.23        | 11.71                          | 26                  | 2.19                               |  | 5.08          | 11.31                          | 20                  | 8.41                               |  |
| 120                  | 5.46 | 12.94                          | 23                  | 1.91                               | 5.48        | 12.41                          | 29                  | 2.42                               |  | —             | —                              | —                   | —                                  |  |
| 150                  | 5.62 | —                              | —                   | —                                  | —           | —                              | —                   | —                                  |  | 5.62          | 12.99                          | 20                  | 8.12                               |  |
| 160                  | —    | —                              | —                   | 1.44                               | 5.70        | 13.19                          | 18                  | 1.49                               |  | —             | —                              | —                   | —                                  |  |
| 190                  | 6.04 | 13.39                          | 22                  | 1.76                               | 5.73        | 13.37                          | 17                  | 1.40                               |  | —             | —                              | —                   | —                                  |  |
| 200                  | —    | —                              | —                   | —                                  | —           | —                              | —                   | —                                  |  | —             | —                              | —                   | —                                  |  |
| Bottom               | 5.80 | 13.59                          | 22                  | 1.76                               | 5.78        | 13.44                          | 17                  | 1.40                               |  | 5.77          | 13.55                          | 10                  | 8.09                               |  |
| 220 m.               |      |                                |                     |                                    | 220 m.      |                                |                     |                                    |  | 220 m.        |                                |                     |                                    |  |
| % of North Sea water |      |                                |                     |                                    | 40.0        |                                |                     |                                    |  | 38.0          |                                |                     |                                    |  |
| 43.7                 |      |                                |                     |                                    |             |                                |                     |                                    |  |               |                                |                     |                                    |  |
| 29. X. 1955          |      |                                |                     |                                    | 17. V. 1956 |                                |                     |                                    |  | 6. VIII. 1956 |                                |                     |                                    |  |
| Depth in m.          | °C.  | S <sup>0</sup> / <sub>00</sub> | °C.                 | S <sup>0</sup> / <sub>00</sub>     | °C.         | S <sup>0</sup> / <sub>00</sub> | O <sub>2</sub><br>% | O <sub>2</sub><br>cm. <sup>3</sup> |  | °C.           | S <sup>0</sup> / <sub>00</sub> | O <sub>2</sub><br>% | O <sub>2</sub><br>cm. <sup>3</sup> |  |
| 0                    | 9.22 | 7.24                           | 2.47                | 7.84                               | 15.26       | 7.28                           | 99                  | 6.82                               |  | 9.38          | 7.43                           | 96                  | 7.48                               |  |
| 10                   | 9.24 | 7.24                           | 2.49                | 7.84                               | 14.30       | 7.28                           | 98                  | 6.89                               |  | 9.46          | 7.43                           | 96                  | 7.44                               |  |
| 20                   | 9.26 | 7.28                           | 2.29                | 7.84                               | 14.02       | 7.28                           | 95                  | 6.72                               |  | 9.45          | 7.43                           | 96                  | 7.42                               |  |
| 30                   | 9.29 | 7.32                           | 1.24                | 7.88                               | 1.98        | 7.82                           | 98                  | 9.06                               |  | 9.56          | 7.48                           | —                   | —                                  |  |
| 40                   | 4.55 | 7.75                           | 1.19                | 7.89                               | 2.06        | 7.86                           | 98                  | 9.09                               |  | 2.44          | 7.89                           | 95                  | 8.68                               |  |
| 50                   | —    | —                              | 1.05                | 7.91                               | —           | —                              | —                   | —                                  |  | 1.48          | 7.97                           | —                   | —                                  |  |
| 60                   | 2.78 | 8.11                           | 1.42                | 8.13                               | 1.18        | 7.86                           | 94                  | 8.93                               |  | 1.50          | 8.11                           | 85                  | 7.99                               |  |
| 80                   | 4.78 | 10.84                          | 4.30                | 10.19                              | 4.36        | 10.57                          | 29                  | 2.49                               |  | 3.43          | 9.92                           | 40                  | 3.49                               |  |
| 100                  | 5.02 | 11.58                          | 5.06                | 11.25                              | 4.90        | 11.11                          | 23                  | 1.93                               |  | 4.85          | 11.22                          | 19                  | 1.64                               |  |
| 120                  | —    | —                              | —                   | —                                  | —           | —                              | —                   | —                                  |  | —             | —                              | —                   | —                                  |  |
| 150                  | 5.64 | 12.88                          | 5.53                | 12.56                              | 1.46        | 12.70                          | 11                  | 0.92                               |  | 5.50          | 12.77                          | 9                   | 0.72                               |  |
| 160                  | —    | —                              | —                   | —                                  | —           | —                              | —                   | —                                  |  | —             | —                              | —                   | —                                  |  |
| 190                  | —    | —                              | —                   | —                                  | —           | —                              | —                   | —                                  |  | —             | —                              | —                   | —                                  |  |
| 200                  | 5.72 | 13.40                          | —                   | —                                  | 5.68        | 13.33                          | 5                   | 0.37                               |  | 5.68          | 13.27                          | 3                   | 0.21                               |  |
| Bottom               | —    | —                              | 5.80                | 13.51                              | 5.74        | 13.38                          | 1                   | 0.07                               |  | 5.68          | 13.35                          | 4                   | 0.29                               |  |
| 235 m.               |      |                                |                     |                                    | 220 m.      |                                |                     |                                    |  | 205 m.        |                                |                     |                                    |  |
| % of North Sea water |      |                                |                     |                                    | 37.7        |                                |                     |                                    |  | 37.8          |                                |                     |                                    |  |
| 39.3                 |      |                                |                     |                                    | 38.9        |                                |                     |                                    |  |               |                                |                     |                                    |  |

7‰ salinity, and North Sea waters entering the Baltic Sea to be 17‰.

Tables 7 and 8 show the results of these calculations.

The inflow of new water is also confirmed by the high oxygen content in the bottom layers of Gothland Deep in February 1955, and of the Northern Deep in June 1955.

G. ZAITSEV

### 3. Recent Data on Oxygen Content in the Central Baltic

Regular determination of the oxygen content in the Baltic enables an assessment to be made of the rate of organic production by phytoplankton through photosynthesis. Atmospheric aeration can-

not usually raise the saturation of sea water above 95–98%. Nevertheless, in some localities the oxygenation of the upper layer surpasses 100%. The following oxygen contents were observed in recent years in the Baltic:—

| Locality          | February         | May       |
|-------------------|------------------|-----------|
| Bornholm Deep .   | 85%—(96%)        | 102%—106% |
| Gdansk Deep . . . | 79%—88% (90%)    | 107%—109% |
| Gothland Deep .   | 100%             | 103%—110% |
| Northern Deep .   | 84%—88%          | 102%—112% |
| September         |                  |           |
| Bornholm Deep .   | 84%—95%          |           |
| Gdansk Deep . . . | 89%—97% (102%)   |           |
| Gothland Deep .   | 94%—105%         |           |
| Northern Deep .   | 102%—103% (116%) |           |

The organic matter from dead organisms and metabolic processes serves as an agent for the

biochemical consumption of oxygen, which in the surface layer amounts to 0.2—0.6 and on some occasions to 1.2 mg. of oxygen in less than 3 days. At the same time, incubation for 3 days of sea water taken from depths exceeding 85—90 m. showed that in most cases the usual analytical

methods for measuring oxygen consumption were inadequate, on account of the very low values.

This again confirms the view that the chemical state of the surface layers differs sharply from that of the deep layers in the Baltic. The organic matter in the deep water is biochemically inert.

M. FEDOSOV

## Plankton

### Productivity in the Baltic

(Table 9)

Investigations were made on the phosphorus economy in the Baltic. As a first step the quantity of total P and its relation to inorganic P was determined on a cruise round Seeland in April and on another cruise from Kiel to Helsinki and back in July/August 1956. From a consideration of the ratio of total to bound phosphorus (= total — inorganic P) — the P-conversion factor — we may obtain information about certain biological processes. The processes of assimilation as well as of mineralization are closely connected with this factor. If its value is 1, all the phosphorus is combined with organic substances by assimilation; if it is  $\infty$ , all P is mineralized. Thus this factor serves as an indicator of the different stages in the cycle of the living material in the sea.

In addition, the weights of chlorophyll and seston per litre are given. Used with caution, these may be taken as roughly representative of the degree of assimilation and the quantity of assimilated substances present. The data on the albumin content and the plankton counts have yet to be published. The data now published are an extract from a larger collection which is to be published in Vol. 13 of "Kieler Meeresforschungen".

The following explanatory remarks on Table 9 may be found useful. In general, the values of total P (0.1 to 0.8  $\mu\text{g.at./l.}$ ), observed in the upper layer are low, they rise considerably near the bottom, to more than 4  $\mu\text{g.at./l.}$  This increase with depth is not continuous, and usually indicate the heterogeneity of the different layers, as shown also by the thermograms. This is especially so in Arcona Basin, and less so in Bornholm Basin and further north. Between the two layers a zone of minimal total P may occur, as can be clearly seen in Bornholm Basin and at some stations in the approaches to the Gulf of Finland. This minimum

is closely connected with the cold winter or spring waters of low salinity.

Inorganic  $\text{PO}_4$  phosphorus increases from the surface (0—0.08  $\mu\text{g.at./l. P}$ ) towards the bottom (up to 2.28  $\mu\text{g.at./l. P}$ ), as many investigators have observed, the greatest relative increase occurring in the salinity discontinuity layer. The difference between total P and inorganic P (bound P) usually decreases from the surface towards the bottom. The explanation lies in the age of the water bodies, to which is related the degree to which the organic substances are decomposed by grazing, autolysis, and fermentation processes.

The P-conversion factor is roughly comparable with the chlorophyll figures. With certain exceptions relatively high chlorophyll content is correlated with P-conversion factors  $< 2$  and vice versa. Chlorophyll, both dead and alive, regularly give higher values in the upper layers than in the lower, though the concentration is low everywhere.

Seston also give low values. If we consider an optimal case such that all seston consists of living plankton, then 1 mg. of seston may be reckoned as containing 10  $\mu\text{g.P/l.}$  or 0.32  $\mu\text{g.at./l.P.}$  Accordingly it appears that in the upper layer only a relatively low proportion of the bound phosphorus is combined in particulate matter, most of it being bound to organic substances in solution. On two occasions we succeeded in getting samples which indicated relatively high concentrations of seston in the discontinuity layer (at 22 m. in Bornholm Basin, and at 24 m. in Gothland Basin). It seems probable that near the thermocline in the central Baltic there is a thin layer in which the seston consists of living plankton and detritus and is relatively abundant.

Comparison of these values of seston and chlorophyll with those for coastal regions in the North Sea in August indicates a low rate of production in the central Baltic at least.

J. KREY

Table 9. Seston, chlorophyll, and phosphorus in the Baltic in 1956  
Arcona Basin

| 55°17'N., 12°33'E.<br>24. April 1956  |        |        |                       |      |      |     | 54°47'N., 12°37'E.<br>24. April 1956                                                                                                                                                                                                        |        |                       |      |      |     |
|---------------------------------------|--------|--------|-----------------------|------|------|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-----------------------|------|------|-----|
| Depth (m.)                            | Seston | Chlor. | PO <sub>4</sub> '''-P | ΣP   | d    | F   | Seston                                                                                                                                                                                                                                      | Chlor. | PO <sub>4</sub> '''-P | ΣP   | d    | F   |
| 0                                     | 0.4    | 0.3    | 0                     | 0.45 | 0.45 | 1   | 0.4                                                                                                                                                                                                                                         | 0.4    | 0.01                  | 0.68 | 0.67 | 1.0 |
| 5                                     | 1.7    | 0.3    | 0                     | 0.45 | 0.45 | 1   | 0.6                                                                                                                                                                                                                                         | 0.5    | 0.04                  | 0.68 | 0.64 | 1.1 |
| 10                                    | 0.6    | 0.5    | 0                     | 0.45 | 0.45 | 1   | 0.9                                                                                                                                                                                                                                         | 0.5    | 0.02                  | 1.02 | 1.00 | 1.0 |
| 15                                    | 0.6    | 0.5    | 0                     | 0.45 | 0.45 | 1   | 0.6                                                                                                                                                                                                                                         | 0.4    | 0.02                  | 1.12 | 1.10 | 1.0 |
| 20                                    | —      | —      | —                     | —    | —    | —   | 1.4                                                                                                                                                                                                                                         | 0.3    | 0.11                  | 0.53 | 0.42 | 1.3 |
| 21                                    | 0.5    | 0.4    | 0.02                  | 0.45 | 0.43 | 1   | —                                                                                                                                                                                                                                           | —      | —                     | —    | —    | —   |
| 25                                    | —      | —      | —                     | —    | —    | —   | 0.6                                                                                                                                                                                                                                         | 0.6    | 0.12                  | 1.08 | 0.96 | 1.1 |
| 54°59'N., 13°29'E.<br>10. August 1956 |        |        |                       |      |      |     | Discontinuity layer = .....<br>Seston in mg. dry substance/l. PO <sub>4</sub> '''-P μg.at./l.<br>Chlorophyll in μg./l. P in μg. at./l.<br>$d = P - (PO_4 - P) = \text{bound } P$<br>$F = \frac{P}{d} = \text{phosphorus-conversion factor}$ |        |                       |      |      |     |
| 5                                     | 0.1    | 0.5    | 0                     | 0.38 | 0.38 | 1   |                                                                                                                                                                                                                                             |        |                       |      |      |     |
| 10                                    | 0.1    | 0.6    | 0                     | 0.41 | 0.41 | 1   |                                                                                                                                                                                                                                             |        |                       |      |      |     |
| 20                                    | 0      | 1.0    | 0.03                  | 0.26 | 0.23 | 1.1 |                                                                                                                                                                                                                                             |        |                       |      |      |     |
| 30                                    | 0.1    | 0.3    | 0.07                  | 0.34 | 0.27 | 1.3 |                                                                                                                                                                                                                                             |        |                       |      |      |     |
| 37                                    | —      | —      | —                     | 0.24 | —    | —   |                                                                                                                                                                                                                                             |        |                       |      |      |     |
| 38.5                                  | 0.1    | 0.4    | 0.21                  | 0.40 | 0.19 | 2.1 |                                                                                                                                                                                                                                             |        |                       |      |      |     |
| 43                                    | 0.3    | 0.4    | 0.43                  | 0.60 | 0.17 | 3.5 |                                                                                                                                                                                                                                             |        |                       |      |      |     |
| 45                                    | —      | —      | —                     | 0.38 | —    | —   |                                                                                                                                                                                                                                             |        |                       |      |      |     |

## Bornholm Basin

| 55°18'N., 15°13'E.<br>24. July 1956 |        |        |                       |      |      |     | 55°18'N., 15°15'E.<br>7. August 1956 |        |                       |      |      |     |
|-------------------------------------|--------|--------|-----------------------|------|------|-----|--------------------------------------|--------|-----------------------|------|------|-----|
| Depth (m.)                          | Seston | Chlor. | PO <sub>4</sub> '''-P | ΣP   | d    | F   | Seston                               | Chlor. | PO <sub>4</sub> '''-P | ΣP   | d    | F   |
| 5                                   | 0.4    | 0.4    | 0.06                  | 0.80 | 0.74 | 1.1 | 0.1                                  | 0.7    | 0.08                  | 0.22 | 0.14 | 1.6 |
| 10                                  | 0.3    | 0.4    | 0.07                  | 0.78 | 0.71 | 1.1 | 0.2                                  | 0.8    | 0.03                  | 0.22 | 0.19 | 1.2 |
| 15                                  | —      | —      | —                     | —    | —    | —   | —                                    | —      | —                     | 0.12 | —    | —   |
| 20                                  | —      | —      | —                     | 0.62 | —    | —   | —                                    | —      | —                     | 0.04 | —    | —   |
| 22                                  | 0.5    | 0.7    | 0.07                  | 0.10 | 0.03 | 3.3 | —                                    | —      | —                     | —    | —    | —   |
| 28                                  | —      | —      | —                     | —    | —    | —   | 0.2                                  | 0.5    | 0.03                  | 0.26 | 0.23 | 1.1 |
| 30                                  | 0.2    | 0.1    | 0.21                  | —    | —    | —   | —                                    | —      | —                     | 0.38 | —    | —   |
| 40                                  | —      | —      | —                     | 0.47 | —    | —   | 0.2                                  | 0.3    | 0.06                  | 0.10 | 0.04 | 2.5 |
| 42                                  | 0.1    | 0.2    | 0.31                  | —    | —    | —   | —                                    | —      | —                     | —    | —    | —   |
| 50                                  | —      | —      | —                     | 0.47 | —    | —   | 0.1                                  | 0.2    | 0.19                  | 0.39 | 0.20 | 2.0 |
| 60                                  | 0.2    | 0.2    | 0.41                  | 0.41 | 0    | ∞   | 0.2                                  | 0.4    | 0.33                  | 0.37 | 0.04 | 9.5 |
| 70                                  | —      | —      | —                     | 2.18 | —    | —   | —                                    | —      | —                     | 1.12 | —    | —   |
| 80                                  | 0.1    | 0      | 2.28                  | 2.40 | 0.12 | 20  | 0.3                                  | 0.1    | 1.90                  | 2.98 | 1.08 | 2.8 |
| 90                                  | —      | —      | —                     | 2.68 | —    | —   | —                                    | —      | —                     | 4.23 | —    | —   |
| 95                                  | —      | —      | —                     | —    | —    | —   | —                                    | —      | —                     | 3.63 | —    | —   |
| 100                                 | —      | —      | —                     | 3.24 | —    | —   | —                                    | —      | —                     | —    | —    | —   |

## Gothland Basin

| 57°16'N., 19°30'E.<br>5. August 1956 |        |        |                       |      |      |     | 56°43'N., 17°17'E.<br>6. August 1956 |        |                       |      |      |     |
|--------------------------------------|--------|--------|-----------------------|------|------|-----|--------------------------------------|--------|-----------------------|------|------|-----|
| Depth (m.)                           | Seston | Chlor. | PO <sub>4</sub> '''-P | ΣP   | d    | F   | Seston                               | Chlor. | PO <sub>4</sub> '''-P | ΣP   | d    | F   |
| 5                                    | —      | —      | —                     | 0.64 | —    | —   | 0.2                                  | 0.8    | 0.10                  | 0.29 | 0.19 | 1.5 |
| 10                                   | —      | —      | —                     | 0.51 | —    | —   | 0.3                                  | 1.4    | 0.07                  | 0.32 | 0.25 | 1.3 |
| 15                                   | —      | —      | —                     | 0.56 | —    | —   | —                                    | —      | —                     | 0.54 | —    | —   |
| 20                                   | —      | —      | —                     | 0.61 | —    | —   | —                                    | —      | —                     | 0.52 | —    | —   |
| 24                                   | —      | —      | —                     | —    | —    | —   | 0.7                                  | 1.7    | 0.08                  | —    | —    | —   |
| 30                                   | —      | —      | —                     | 0.27 | —    | —   | 0.1                                  | 0.4    | 0.15                  | 0.60 | 0.45 | 1.3 |
| 40                                   | —      | —      | —                     | 0.12 | —    | —   | —                                    | —      | —                     | 0.37 | —    | —   |
| 50                                   | —      | —      | —                     | 0.10 | —    | —   | —                                    | —      | —                     | 0.85 | —    | —   |
| 60                                   | —      | —      | —                     | 0.24 | —    | —   | 0.1                                  | 0      | 0.20                  | 0.29 | 0    | —   |
| 70                                   | —      | —      | —                     | 0.84 | —    | —   | —                                    | —      | —                     | —    | —    | —   |
| 80                                   | —      | —      | —                     | 1.17 | —    | —   | —                                    | —      | —                     | 0.11 | —    | —   |
| 100                                  | —      | —      | —                     | 0.49 | —    | —   | 0.1                                  | 0.1    | 0.90                  | —    | —    | —   |
| 125                                  | —      | —      | —                     | 1.10 | —    | —   | 0.3                                  | 0.1    | 1.20                  | 1.78 | 0.58 | 3.1 |
| 150                                  | 0.1    | 0.2    | 1.46                  | —    | —    | —   | 0.3                                  | 0.1    | 2.50                  | 2.90 | 0.40 | 7.3 |
| 175                                  | 0.2    | 0.05   | 1.60                  | 1.68 | 0.08 | 21  | —                                    | —      | —                     | —    | —    | —   |
| 200                                  | 0.2    | 0.05   | 1.87                  | 2.27 | 0.40 | 5.7 | —                                    | —      | —                     | —    | —    | —   |

Table 9 (continued)

| Gulf of Finland    |        |       |                       |      |      |     |
|--------------------|--------|-------|-----------------------|------|------|-----|
| 59°36'N., 22°22'E. |        |       |                       |      |      |     |
| 4. August 1956     |        |       |                       |      |      |     |
| Depth<br>(m.)      | Seston | Chlor | PO <sub>4</sub> '''-P | ΣP   | d    | F   |
| 5 .....            | 0.3    | 0.6   | 0.04                  | —    | —    | —   |
| 10 .....           | 0.3    | 0.8   | 0.04                  | 1.39 | 1.35 | 1.0 |
| 15 .....           | 0.5    | 1.5   | 0.07                  | 0.42 | 0.35 | 1.2 |
| 20 .....           | 0.5    | 0.8   | 0.08                  | 0.76 | 0.68 | 1.1 |
| 30 .....           | 0.3    | 0.4   | 0.11                  | 0.16 | 0.05 | 3.2 |
| 40 .....           | 0      | 0.3   | 0.16                  | 0.37 | 0.21 | 1.8 |
| 50 .....           | 0.5    | 1.1   | 0.14                  | 0.36 | 0.22 | 1.6 |
| 60 .....           | —      | —     | —                     | 0.71 | —    | —   |

### Zooplankton in the Central Baltic and in the Gulf of Riga in 1956

(Figures 12-13; Tables 10-11)

Plankton development in 1956 took place under fairly favourable conditions as regards biogenic mineral salts, thanks to discharge of fresh water from the rivers well above the long-period average (Fig. 12) and to intensive mixing resulting from more stormy days than usual. In spite of the late and cold spring, the quantity of plankton present in the central Baltic was close to normal, even in May; in the Gulf of Riga it exceeded the normal (Tables 10 and 11). However, by June—July in the Gulf of Riga and July in the central basin the quantity of plankton has noticeably declined, as

Table 10. Average numbers of crustacea in the central Baltic in 1956 and other years (in m.<sup>3</sup>)

|                  | 1949   | 1951  | 1952     | 1953    | 1954   | 1955   | 1956   | 1949—1956 |
|------------------|--------|-------|----------|---------|--------|--------|--------|-----------|
| 0—25 m. Layer    |        |       |          |         |        |        |        |           |
| February .....   | —      | —     | 2,450    | 920     | —      | 3,740  | —      | 2,370     |
| April .....      | 3,940  | —     | —        | —       | —      | 1,700  | —      | 2,820     |
| May .....        | 19,860 | —     | —        | —       | 5,440  | 10,110 | 8,680  | 11,020    |
| June .....       | 3,970  | —     | 16,410   | —       | 22,440 | —      | 14,180 | 14,250    |
| July .....       | 7,770  | —     | —        | 32,240  | 13,220 | 16,560 | 7,880  | 15,540    |
| August .....     | 10,260 | —     | —        | 15,260  | —      | 11,960 | —      | 12,490    |
| September .....  | 11,770 | 6,970 | —        | —       | —      | 10,030 | —      | 9,590     |
| October .....    | 5,310  | 5,770 | —        | —       | 7,410  | —      | —      | 6,160     |
| November .....   | —      | —     | —        | —       | 9,790  | —      | —      | —         |
| December .....   | —      | —     | —        | —       | —      | —      | 4,053  | —         |
| 25—50 m. Layer   |        |       |          |         |        |        |        |           |
| February .....   | —      | —     | —        | 1,670   | —      | 1,490  | —      | 1,580     |
| April .....      | 1,200  | —     | —        | —       | —      | 780    | —      | 990       |
| May .....        | 1,090  | —     | —        | —       | 3,070  | 5,990  | 3,800  | 3,490     |
| June .....       | 5,270  | —     | (11,190) | —       | 5,670  | —      | —      | (7,380)   |
| July .....       | 6,440  | —     | —        | 7,700   | 6,220  | 4,930  | 7,660  | 6,590     |
| August .....     | 3,650  | —     | —        | 6,870   | —      | 2,600  | —      | 4,370     |
| September .....  | 4,020  | 7,780 | —        | —       | —      | 5,570  | —      | 5,790     |
| October .....    | 2,820  | 5,470 | —        | —       | 4,490  | —      | —      | 4,260     |
| November .....   | —      | —     | —        | —       | 4,070  | —      | —      | —         |
| December .....   | —      | —     | —        | —       | —      | —      | 6,115  | —         |
| 50—100 m. Layer  |        |       |          |         |        |        |        |           |
| February .....   | —      | —     | —        | 940     | —      | 1,150  | —      | 1,045     |
| April .....      | —      | —     | —        | —       | —      | 640    | —      | (640)     |
| May .....        | 210    | —     | —        | —       | 770    | 5,690  | 2,550  | 2,300     |
| June .....       | 60     | —     | (4,010)  | —       | 1,090  | —      | —      | 1,720     |
| July .....       | 2,180  | —     | —        | (2,740) | 1,140  | 3,570  | 3,620  | 2,650     |
| August .....     | 2,020  | —     | —        | 1,980   | —      | 3,530  | —      | 2,540     |
| September .....  | 3,810  | —     | —        | —       | —      | 3,820  | —      | 3,815     |
| October .....    | 1,550  | 4,660 | —        | —       | (810)  | —      | —      | 2,350     |
| November .....   | —      | —     | —        | —       | 3,710  | —      | —      | —         |
| 100—150 m. Layer |        |       |          |         |        |        |        |           |
| May .....        | 850    | —     | —        | —       | —      | 570    | (965)  | 795       |
| June .....       | 15     | —     | —        | —       | —      | —      | —      | —         |
| July .....       | 290    | —     | —        | —       | —      | 350    | —      | 320       |
| August .....     | 500    | —     | —        | 320     | —      | —      | —      | 410       |



Table 11. Average numbers of crustacea in the Gulf of Riga in 1948—1956 (in m.<sup>3</sup>)

|                     | 1948   | 1950   | 1951   | 1952     | 1953    | 1954    | 1955   | 1956     | 1948—1956 |
|---------------------|--------|--------|--------|----------|---------|---------|--------|----------|-----------|
| 0—20 m. Layer       |        |        |        |          |         |         |        |          |           |
| January .....       | —      | —      | —      | —        | —       | —       | 5,590  | —        | (5,590)   |
| February ....       | —      | —      | 990    | —        | —       | —       | 6,410  | —        | 3,700     |
| April .....         | —      | 1,440  | —      | 4,330    | —       | —       | —      | —        | 2,880     |
| May .....           | —      | 6,760  | 3,200  | 6,690    | 13,220  | 5,520   | 6,310  | 8,000    | 7,100     |
| June .....          | —      | 10,760 | 11,600 | 13,630   | 11,240  | 9,190   | 9,060  | 6,360    | 10,270    |
| July .....          | —      | 11,540 | 23,480 | —        | 25,540  | 22,700  | 31,420 | —        | 22,950    |
| August .....        | —      | 25,440 | —      | —        | —       | 21,220  | —      | 21,740   | —         |
| September ...       | —      | 11,030 | —      | —        | —       | 15,950  | —      | 23,240   | 16,740    |
| October .....       | —      | 9,400  | —      | —        | 13,650  | 11,530  | —      | (26,430) | 15,250    |
| November ...        | —      | 3,650  | —      | —        | —       | 3,690   | —      | 4,200    | 3,840     |
| December ...        | —      | 2,230  | —      | —        | —       | —       | —      | —        | (2,230)   |
| 20—40 (50) m. Layer |        |        |        |          |         |         |        |          |           |
| 0—40 m.             |        |        |        |          |         |         |        |          |           |
| January .....       | 700    | —      | —      | —        | —       | —       | —      | —        | —         |
| February ....       | 990    | —      | —      | —        | —       | —       | —      | —        | —         |
| April .....         | 1,800  | 920    | —      | 510      | —       | —       | —      | —        | 720       |
| May .....           | 4,730  | 4,520  | —      | 5,430    | 1,880   | 1,050   | 810    | 2,100    | 2,630     |
| June .....          | 7,260  | 4,090  | —      | —        | 2,890   | 3,190   | 790    | 2,230    | 2,640     |
| July .....          | 14,520 | 190    | —      | —        | (1,800) | —       | 16,420 | —        | 6,140     |
| August .....        | 12,690 | 2,060  | —      | —        | —       | —       | —      | 6,060    | 4,060     |
| September ...       | 11,280 | —      | —      | —        | —       | 17,160  | —      | 10,370   | 13,760    |
| October .....       | 7,120  | 830    | —      | —        | 1,810   | 5,400   | —      | (3,310)  | 2,840     |
| November ...        | 3,180  | 3,330  | —      | —        | —       | 2,060   | —      | 2,440    | 2,610     |
| 0—20 m. Layer       |        |        |        |          |         |         |        |          |           |
| May—July ..         | —      | 9,690  | 12,760 | (10,160) | 16,670  | 12,470  | 15,600 | (7,180)  | 13,440    |
| 20—40 m. Layer      |        |        |        |          |         |         |        |          |           |
| May—July ..         | 8,840  | 2,930  | —      | —        | 2,190   | (2,120) | 6,010  | (2,165)  | 3,800     |

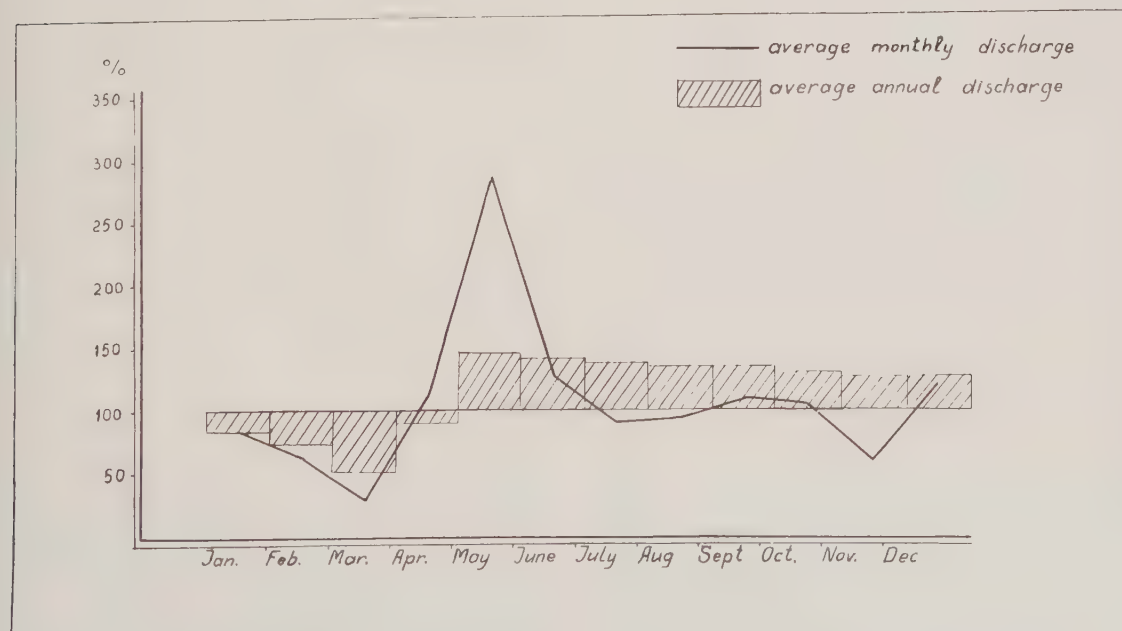


Figure 12. Discharge of the Daugava river in 1956, in relation to the long-period mean.

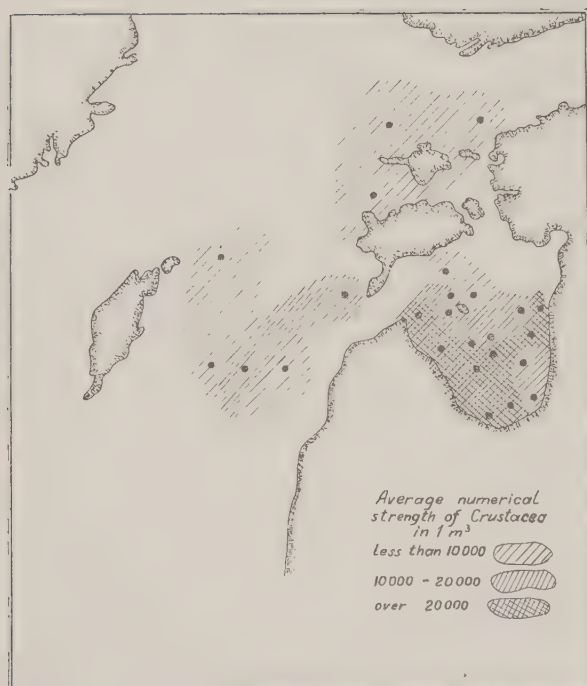


Figure 13. Production of zooplankton in the 0—40 (50) m. layer in the Gulf of Riga (1.—7. August) and north-eastern Baltic (22.—24. July) in 1956.

compared with the long-period mean. This decrease is explained in part by the fact that the development of warm-water crustacea was delayed by the slowness with which the water heated and possibly by a rather heavy consumption of plankton by a very rich population of young herring and sprat (of the 1955 year-class).

By the end of summer and in the autumn the quantity of plankton had become exceedingly high due to favourable temperatures in September and October especially in the latter month. Figure 13 shows the difference between plankton production in the Gulf of Riga and in the northern part of the central Baltic.

I. NIKOLAEV

#### Zooplankton Investigations in the Gulf of Bothnia

1955

In the summer of 1955 routine plankton samples were collected for observation of the composition of the zooplankton, in connexion with herring investigations in the Gulf of Bothnia. Most of the samples were taken in two districts, namely in the archipelago off Luleå (approx. position, 65°40'N., 23°0'E.) and off the coast of Medelpad (south of

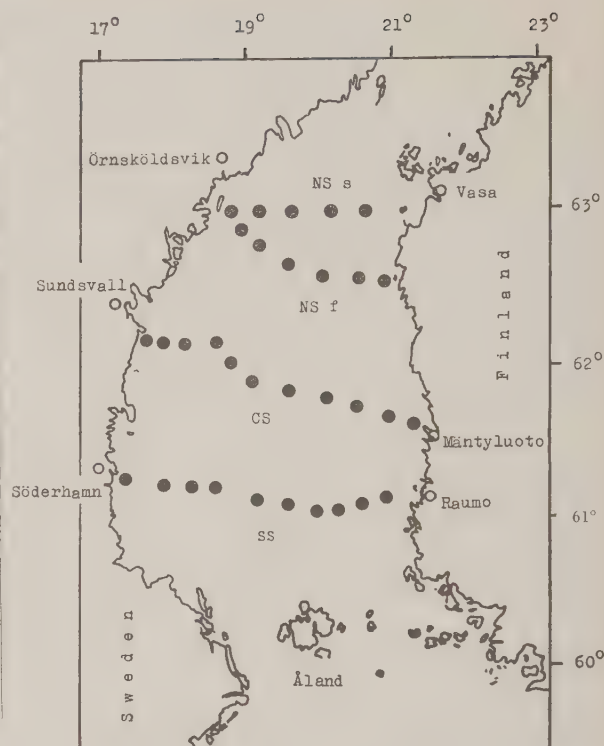


Figure 14. The Gulf of Bothnia. Position of sections and stations in 1956.

NS s = northern section, Sweden; NS f = northern section Finland; CS = central section; SS = southern section.

Sundsvall, ca. 62°0'N., 17°40'E.). The most abundant species in the samples from the Luleå archipelago in September were *Bosmina coregoni maritima* P. E. MÜLLER and *Daphnia* spp. *Limnocalanus grimaldii* (DE GUERNE) was taken only in the outer part of the archipelago in relatively deep water (50 m.). This form often occurs off the coast of Medelpad in immense concentrations in fairly deep water below the discontinuity layer; as, for instance at the station off Brämökalv on 29. July. Four vertical hauls were made with the Hensen net (gauze No. 3): —

| Hour  | Depth of hauls<br>m. | Number of<br><i>Limnocalanus grimaldii</i> |
|-------|----------------------|--------------------------------------------|
| 08.30 | 40—0                 | 360                                        |
|       | 50—0                 | 5,350                                      |
| 11.00 | 40—0                 | 880                                        |
|       | 60—0                 | 20,300                                     |

(bottom depth ca. 60 m., temperature (0830 hrs.) at surface 15.6°C.; 15 m., 14.7°; 20 m., 4.0°; 30 m., 2.9°; 50 m., 2.0°C.). Mr. G. OTTERLIND stated that the ELAC echo-graph recorded distinct signals from between 45 and 60 m.

As regards the plankton disease recorded by VALLIN (Ann. Biol., Vol. X, p. 138) only two

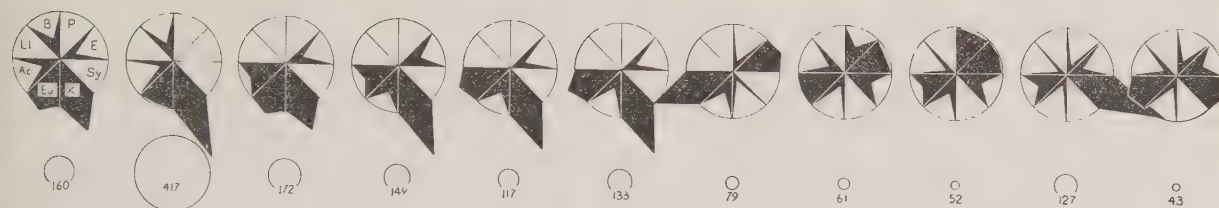


Figure 15. Composition of zooplankton and total numbers of animals in the samples of the central section, 13. to 14. August 1956, R/V "Eystrasalt". Each circular figure represents the sample from one station.

Left: Swedish coastal station. Right: Finnish coastal station.

Upper row: composition of the samples. Each circular figure is divided into 8 sectors and each sector represents one of the most abundant species in the plankton, as indicated in the figure; abbreviations: Eu = *Eurytemora hirundoides*, Ac = *Acartia bifilosa*, Ll = Lamellibranchiata larvae, B = *Bosmina coregoni maritima*, P = *Podon* sp., E = *Evadne nordmanni*, Sy = *Synchaeta* sp., K = *Kera-*

*tella quadrata platei*. The distance from the centre of the circle and to the vertex of the sector, centrifugal or centripetal, represents the numbers of the species in question given as a percentage of the total number of animals in the sample.

Lower row: Total numbers (thousands) of animals in each sample.

individuals of *Eurytemora hirundoides* NORDQVIST (caught off Juniskär, south of Sundsvall, on 5. and 9. September) from about 60 samples taken in 1955 showed an infection of a parasitic mould like *Lep-tolepnia baltica* HÖHNK et VALLIN.

#### 1956 (Figures 14 and 15)

In April 1956 a conference between Finnish and Swedish fishery biologists and hydrographers was held in Stockholm to establish a co-operation programme of fishery research in the Gulf of Bothnia. In accordance with this plan plankton samples were taken and hydrographical observations made in the Gulf of Bothnia 1956 by the Swedish research vessel "Eystrasalt" and the Finnish research vessel "Aranda". The stations were located on several sections across the Gulf of Bothnia (Fig. 14). In all, 79 plankton samples were collected on the following sections: —

| Research vessel | Northern section | Central section | Southern section |
|-----------------|------------------|-----------------|------------------|
| "Eystrasalt"    | 12. July         | 20.—21. June    | 18.—19. June     |
| "Eystrasalt"    | 22. Oct.         | 13.—14. Aug.    | —                |
| "Eystrasalt"    | —                | 24.—25. Oct.    | —                |
| "Aranda"        | 8. June          | —               | 5.—7. June       |
| "Aranda"        | —                | —               | 14.—15. June     |

The plankton samples were taken with nets (usually Hensen nets) of gauze No. 8 (32—34 threads per cm.). At each station a single vertical haul was made, as a rule from 50 m. to the surface.

The most common species in the samples were: — the copepods *Limnocalanus grimaldii*, *Acartia bifilosa*, *Eurytemora hirundoides*; the Cladocera *Evadne nordmanni*, *Podon polyphemoides*, *P. intermedius*, *Bosmina coregoni maritima*; the Rotatoria

*Synchaeta baltica*, *S. monopus*, *Keratella quadrata platei*.

A new northern limit of distribution of some of the less abundant species was recorded, e. g., for the copepods *Centropagus hamatus* and *Temora longicornis*, polychaet larvae, presumably *Harmothoe sarsi*, which all occurred on the Swedish part of the northern section.

On the central and southern sections the plankton composition was relatively uniform over wide areas; there was a marked difference, however, between the composition of the zooplankton in the western part of the Gulf of Bothnia and that in the eastern part. This is exemplified in Figure 15, which shows the composition of the samples collected on the central section on 13.—14. August 1956. This difference in composition of the open-water plankton in the western and eastern parts was evident on all the central and southern sections. The explanation for this feature presumably lies in differences between the hydrographical conditions on the two sides of the Gulf.

With few exceptions (see Fig. 15) there was, in general, no significant differences between the total numbers of zooplankton organisms taken at the stations on one section. The exceptions are certain Swedish and Finnish coastal stations where on some occasions the total numbers of plankton organisms were very large compared with stations further off shore. The composition of the samples was almost the same, however. It was not evident that the central parts of the Gulf of Bothnia were poorer in plankton than the surrounding regions.

A more detailed paper on these investigations is in preparation.

ARMIN LINDQUIST

## THE FISH

## Eggs and Larvae

## Investigations in the Belts and Western Baltic

(Figure 16; Table 12)

The average numbers of eggs per m<sup>2</sup>. near the lightship "Fehrmarnbelt" in the 1956 spawning season were as follows:—

|                        |         | Dec. | Jan. | Feb. | Mar.             | Apr. | May | June | July | Aug. |
|------------------------|---------|------|------|------|------------------|------|-----|------|------|------|
| Cod .....              | 1956    | —    | 0.5  | —    | 12 <sup>1)</sup> | 28   | 12  | 2    | —    | —    |
|                        | 1934—43 | 4    | 15   | 81   | 49               | 24   | 3   | 1    | —    | —    |
| Plaice .....           | 1956    | —    | —    | —    | —                | 0.5  | 0.5 | 0.5  | —    | —    |
|                        | 1934—43 | 0.5  | 0.5  | 2    | 1                | 1    | —   | —    | —    | —    |
| Flounder and Dab ..... | 1956    | —    | —    | —    | 8 <sup>1)</sup>  | 35   | 30  | 11   | 3    | 3    |
|                        | 1934—43 | —    | —    | 8    | 23               | 35   | 35  | 18   | 3    | —    |
| Sprat .....            | 1956    | —    | —    | —    | —                | —    | —   | 28   | 8    | —    |
|                        | 1934—43 | —    | —    | —    | —                | —    | 22  | 60   | 60   | 5    |
| Mackerel .....         | 1956    | —    | —    | —    | —                | —    | —   | 1.5  | 1.5  | —    |
|                        | 1934—43 | —    | —    | —    | —                | —    | —   | 1.5  | 0.2  | —    |

<sup>1)</sup> End of month.

In 1956 the spawning of the cod was retarded and interrupted by the severe cold in February — the lightship was withdrawn on account of ice until the end of March — and the number of cod eggs did not reach the maximum until April, February being the usual month. The quantity of eggs remained low, and amounted only to one-third of the average for 1934—1943. The numbers of flounder and dab eggs were nearly normal, except in March. The sprat does not spawn as much as formerly; the low numbers of eggs indicate that the stock of spawning fish is poor. This year, the number of mackerel eggs was very low in contrast to the year before, when we recorded 15 eggs per m<sup>2</sup> in July. The number of plaice eggs has not shown any increase for many years.

The occurrence of mackerel eggs in the Belt Sea in June/July 1955 and 1956 is shown in Table 12.

The chart, Figure 16, shows the positions and the numbers of mackerel eggs per m<sup>2</sup> obtained on 5 cruises in June/July in 1954, 1955, and 1956.

In mid-June 1955, when we cover only Kiel Bay and the southern part of the Great Belt as far as Korsør, the number of mackerel eggs was low, at

2—8 per m<sup>2</sup>, as compared with 12—39 at the same time the year before. Rather more — 20 per m<sup>2</sup> — were found off Schleimünde, in the western part of Kiel Bay. Two weeks later, at the end of June 1955, more mackerels were spawning. Eggs were obtained at all stations in the Great Belt, in numbers varying between 6 and 24 per m<sup>2</sup>. Only very few eggs were taken in the Little Belt, whereas in the north-western part of Kiel Bay, off Schleimünde, there were 20 per m<sup>2</sup>.

In 1956 the first cruise was undertaken in the middle of June, as in previous years, and was from Kiel to Korsør and back. The distribution of mackerel eggs was very uniform, at 8 per m<sup>2</sup> on the average. It is to be remarked that at that time a very strong influx of high-salinity water took place, which brought enormous quantities of *Aglantha digitalis* into the Belt Sea. In the Great Belt between Kelds Nor and Korsør, we counted 100—230 individuals per m<sup>2</sup>.

A further cruise, round Fyn, was made at the beginning of July. As in the previous year, we found most mackerel eggs — 17 and 26 per m<sup>2</sup> — in the region from Kiel Bay to the southern end of the

Table 12 . Average numbers of mackerel eggs per m<sup>2</sup> in the Belt Sea

(Number of stations in brackets)

| Date                    | Northern<br>Great Belt,<br>N. of 55°10'N.<br>E. of 10°15'E. | Southern<br>Great Belt<br>S. of 55°10'N. | Northern<br>Kiel Bay<br>between<br>54°35'N. and<br>55°10'N. | Southern<br>Kiel Bay<br>S. of 54°35'N. | Little Belt<br>N. of 55°10'N.<br>W. of 10°15'E. |
|-------------------------|-------------------------------------------------------------|------------------------------------------|-------------------------------------------------------------|----------------------------------------|-------------------------------------------------|
| 15.—16. June 1955 ..... | 4.0 (2)                                                     | 4.0 (4)                                  | 20 (1)                                                      | 1.0 (2)                                | —                                               |
| 28.—30. June 1955 ..... | 9.5 (4)                                                     | 19 (2)                                   | 5.8 (4)                                                     | 0.7 (3)                                | 1.0 (5)                                         |
| 14.—15. June 1956 ..... | 5.3 (3)                                                     | 7.8 (5)                                  | 11 (1)                                                      | —                                      | —                                               |
| 3.—5. July 1956 . . .   | 4.4 (5)                                                     | 6.7 (3)                                  | 5.7 (3)                                                     | 13 (3)                                 | 2.2 (5)                                         |



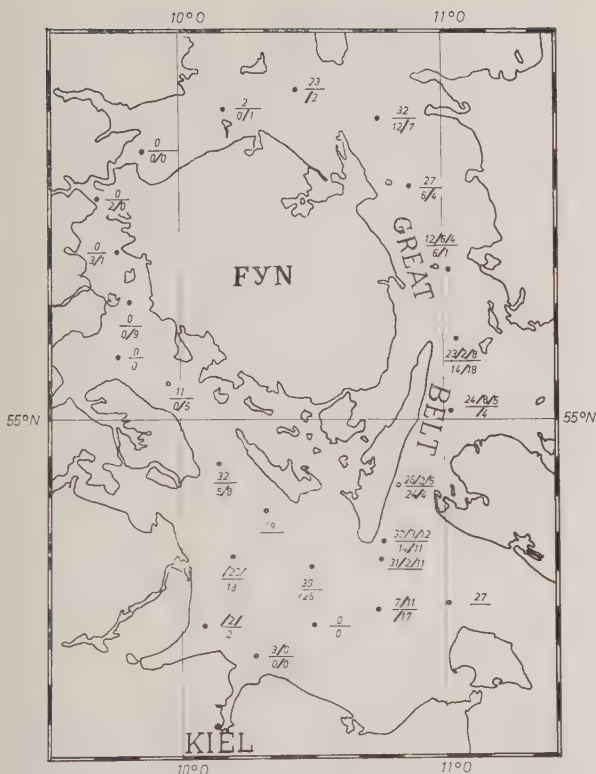


Figure 16. Number of mackerel eggs per m.<sup>2</sup> in Kiel Bay, Great Belt, and Little Belt in June/July 1954–1956.

Over the line:

15.—18. June 1954 / 15.—16. June 1955 / 14.—15. June 1956.

Under the line:

28.—30. June 1955 / 3.—5. July 1956.

Little Belt. In the Great Belt they varied between 1 and 11 per m.<sup>2</sup>.

A very remarkable observation was made north of Fyn, south-west of Samsø, at the beginning of June. There we found large quantities of anchovy eggs, 53 per m.<sup>2</sup>, in quite a restricted space. At

other stations in the Great Belt, Little Belt, and Kiel Bay, only 1–3 per m.<sup>2</sup> were obtained. No such heavy spawning by the anchovy has been observed in this locality hitherto. At the same time enormous quantities of small dab larvae, up to 40 and 90 per m.<sup>2</sup>, were found off the north-east coast of Fyn. The number of dab eggs also was high, up to 167 per m.<sup>2</sup> near Samsø, and 47 per m.<sup>2</sup> in the Little Belt near Assens.

R. KÄNDLER

## Flatfish

### Danish Investigations

#### 1. The numbers of 0- and I-group fish in coastal waters

(Table 13)

The average number of 0-group plaice in the Belts was normal but about 3 times the normal in the western Baltic. In the northern part of the Sound, as far down as Copenhagen, the numbers were below normal but were the same at a few stations in the southern part of the Sound, where the density is normally somewhat lower. No investigations were carried out further to the south in 1956. At Bornholm the average number of 0-group plaice was below normal. It is most unusual for the density of the 0-group plaice to be greater in the western Baltic than in the Belts. Such a condition has been found only very rarely in previous years — as for example 1950 (in this case there is some uncertainty about the result on account of a fault in the trawl used) and 1934, as well as some years when the numbers in both areas were small. The density in the western Baltic 1956 was more than double that in 1955, but was a little lower than that in the Belts. Although the numbers in the western Baltic are, on the average, only half those in the Belts, it is necessary to study that region also each year in order to enable a prognosis to be made of the stock of commercial fish in succeeding years.

Table 13. Numbers of 0- and I-group plaice and of 0-group flounder and turbot caught per hour with the Johansen young-plaice trawl and the hand push-net (h.p.) in 1956

|                     | Number<br>of stations | Plaice  |         | Flounder<br>0-group | Turbot<br>0-group |
|---------------------|-----------------------|---------|---------|---------------------|-------------------|
|                     |                       | 0-group | I-group |                     |                   |
| Belts               |                       |         |         |                     |                   |
| July—September .    | 54                    | 29 (28) | 17      | 6 (0.4)             | 0 (2)             |
| Western Baltic      |                       |         |         |                     |                   |
| September . . . . . | 9                     | 43 (14) | 9       | 0 (2)               | 0 (1)             |
| Sound, August       |                       |         |         |                     |                   |
| Northern part . . . | 7                     | 7 (28)  | 6       | 0 (5)               | 0 (2)             |
| Southern part . . . | 4                     | 8       | 81      | 0                   | 1 (4)             |
| Bornholm . . . . .  | 10                    | 0       | 2       | 183                 | 2                 |
| — (h.p.) . . . . .  | 18                    | 4 (17)  | 0       | 237 (231)           | 4 (25)            |

( ) = means for a series of years

The water temperatures (cf. Tables 1 and 2 p. 99) in the first quarter of the year were low and accordingly we might have expected the strength of the 1956 year-class to be below normal.

In the Belts and western Baltic, and to some extent in the southern Kattegat also, the post-war year-classes of plaice have on the whole been stronger than might have been expected from hydrographical conditions. It may be that the relatively large stock of mature plaice in the years since the war has augmented the quantity of fry.

The density of the 0-group plaice at Bornholm was very much below normal, which is attributable to the low temperature of the water in spring.

In all parts of the region, except Bornholm, the number of I-group plaice was higher than normal, as a result of the richness of the year-class (1955) to which this group belongs; whereas at Bornholm the 1955 year-class as 0-group was less abundant than usual. Extremely large numbers of I-group fish were found in the southern part of the Sound.

In the Belts the 0-group flounder was about 15 times more abundant than usual, but in the western Baltic and the Sound no flounders of this year-class were found. The main stock of 0-group flounder inhabits inshore waters, and in 1956 no opportunity occurred to make quantitative investigations there. Moreover, the strength of flounder year-classes can be estimated with more certainty from the numbers of the I-group fish found on the open coasts in these waters. The average numbers of I-group flounder present in 1956 were comparatively high; 6 in the Belts, 0.3 in the western Baltic, and 10 in the Sound, south of Copenhagen. This confirms the finding of the 1955 investigation, namely, that the 1955 year-class of flounder was rich everywhere in these waters.

In the Baltic the 0-group flounder inhabits the open coasts. At Bornholm they were present in usual numbers.

Very few 0-group turbot were found in the experimental hauls, except at Bornholm, but here also they were fewer than normal. Rather more I-group turbot were found in the Belts and the western Baltic; 0-group turbot were comparatively numerous in these waters in 1955.

An unusually large quantity of 0-group brill was found in the Belts, the western Baltic, and the Sound; the rate of catch was about 1 fish an hour. As a rule, the young stages of this fish are even more rare on these coasts than those of turbot.

The average number of 0-group sole taken was 0.4, which is considerably higher than normal and about the same as in 1955. It is stated in the report to the Near Northern Seas that in 1956 the quantity of 0-group sole was extraordinarily high in Laholm Bay and Skelderviken. No doubt the present large stock of commercial sole will increase even more in 1958 and 1959.

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## Plaice

### The Stock in the Open Sea

(Table 14)

Comparison of the number of plaice caught per hour in the experimental hauls as shown in Table 14 with the corresponding table (Ann. Biol., XII, Table 12, p. 120) shows that fish of commercial size (over 26 cm.) had decreased a little in numbers but those of plaice under the size limit for commercial fish were of about the same magnitude in the two years. Only one haul was made in depths greater than 25 m. in the Belts in 1956, except at the southern end of the little Belt; the water there is deficient in oxygen in summer, and no plaice were found.

The plaice in the Sound were larger than in other waters, as is normal. There were many more plaice of commercial size than in the Belts and

Table 14. Catch of plaice per hour in experimental hauls with the standard trawl in 1956

|                  | Depth zone<br>m. | Number of<br>stations | Centimetre groups |       |       |       |       |       |       |       |       |       |       |
|------------------|------------------|-----------------------|-------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|                  |                  |                       | 6-10              | 11-15 | 16-20 | 21-25 | 26-30 | 31-35 | 36-40 | 41-45 | 46-50 | 51-55 | 56-60 |
| <b>Belts</b>     |                  |                       |                   |       |       |       |       |       |       |       |       |       |       |
| Aug.-Sept. . . . | 5-14             | 9                     | 1                 | 16    | 40    | 17    | 5     | 0.3   | —     | —     | —     | —     | —     |
|                  | 15-24            | 17                    | —                 | 4     | 74    | 49    | 5     | 2     | 0.1   | —     | —     | —     | —     |
|                  | 25-34            | 1                     | —                 | —     | —     | 2     | 2     | 2     | —     | —     | —     | —     | —     |
| <b>Sound</b>     |                  |                       |                   |       |       |       |       |       |       |       |       |       |       |
| April-June . . . | 15-35            | 8                     | —                 | —     | —     | 0.2   | 0.2   | 4     | 5     | 3     | 4     | 1     | 0.5   |
| Oct.-Nov. . . .  | 15-35            | 5                     | —                 | —     | —     | 1     | 2     | 5     | 4     | 2     | —     | —     | —     |
| <b>Møen</b>      |                  |                       |                   |       |       |       |       |       |       |       |       |       |       |
| Sept.-Nov. . . . |                  |                       | 0.2               | —     | —     | 2     | 4     | 2     | —     | —     | —     | —     | —     |
| <b>Bornholm</b>  |                  |                       |                   |       |       |       |       |       |       |       |       |       |       |
| August . . . . . |                  |                       | —                 | —     | —     | —     | 1     | 0.5   | —     | —     | —     | —     | —     |

they weighed very much more. Moreover, the plaice in the Sound were older than those in the Belts. In June a third of the plaice of commercial size were more than 45 cm. long, and some of them were extraordinarily old, over 8 years. The age determination of these old plaice may be somewhat uncertain but many of them without doubt originated from the rich year-classes of 1944, 1945, and 1946. These old, very large plaice were not found in the experimental hauls in October—November, but more than a third of the plaice of commercial size were of the IV and V group, and about half were of the III group; moreover, the II group had begun to enter the stock of commercial plaice. In the Belts intensive fishing keeps the commercial fish young and small, and there the commercial stock consists mostly of II group plaice, with varying numbers of I and III groups (according to year-class strength) and there are always very few older fish.

It is a characteristic of the stock in those parts of the Sound deeper than 15 m. that the younger age-groups are always relatively rare. In recent years it has not been possible to carry out fishing from the "Biologen" at depths less than 15 m., where the younger plaice occur, because of the presence of pound-nets. As a rule, 0-group plaice in the Sound are almost as frequent as they are in the Belts. In 1953 and 1954 the quantity of 0-group plaice taken per hour in the Sound was only about half that obtained in the Belts, in 1952 only about a sixth. It is thus clear that the number of young plaice present in the Sound in the last few years has been exceptionally low.

The reason for the relative abundance of large, old fish in the Sound is that trawling and seining are prohibited there. This has a beneficial effect on the commercial stock in the south-eastern Kattegat and the Møen region.

At those places off Bornholm where experimental trawling could be carried out in 1956, the stock of plaice was very sparse. On the other hand, the fishermen had good catches of plaice on certain small grounds nearer the coast where there are landmarks to guide them. These good catches resulted mainly from the richness of the 1952 year-class, but in summer the strong 1954 year-class began to enter the stock fished by the "Biologen".

AA. J. C. JENSEN

### Transplantation of Plaice to the Belts

Transplantation from Nissum Broad in Limfjord to the Belts was carried out between 18. April and 14. May. A total of 1,073,900 fish weighing 80,545 kg., was liberated in various parts of the Belts.

In the course of this work, 1,300 plaice were tagged with Petersen disks. By the end of the year 10.5% had been recaptured (1954, 9%; 1955, 9%) and as in 1955 most of these were from 4 lots liberated in Smålandshavet (south of Seeland).

In addition, 1,000 plaice were marked with roll-tags (cf. Ann. Biol., XI, p. 66 and XII, p. 121). As in 1955, the best results, such as they were, came from the liberations in Smålandshavet, where 15% of the disks and 12% of the roll-tags were recovered by the end of the year. The results of the liberations in other parts of the Belts were even less satisfactory. The estimated value of the yield from these liberations in 1956 is almost the same as for 1955 (cf. Ann. Biol., XII, p. 121).

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### Dab

The numbers of dab obtained per 1 hour's fishing with the cod trawl from S/S "Biologen" are shown in the following table. The number of hauls is given in brackets.

|                 | 1956     | 1955 |
|-----------------|----------|------|
| N. Belts .....  | 460 (27) | 787  |
| S. Belts .....  | 81 (41)  | 586  |
| W. Baltic ..... | 27 (14)  | 82   |
| Sound .....     | 137 (9)  | 71   |
| Møen .....      | 36 (7)   | 12   |
| Bornholm .....  | 0.9 (7)  | 1.7  |

It will be seen that in all regions, except the Sound and the waters round Møen, the stock of dab in 1956 was inferior to that of 1955. The deficit is particularly distinct in the southern part of the Belts. It may be noticed that the number of dab round Bornholm is negligible.

The size composition of the stock does not differ from that observed in previous years, sizes between 10 and 18 cm. (belonging mainly to the I group) predominating and forming nearly 50% of the fish taken.

J. KNUDSEN



Table 15. Catch of flounder per hour in experimental hauls with the standard trawl in 1956

|                              | Depth<br>zone<br>m. | Number<br>of<br>stations | Centimetre groups |       |       |       |       |       |       | Total |
|------------------------------|---------------------|--------------------------|-------------------|-------|-------|-------|-------|-------|-------|-------|
|                              |                     |                          | 11—15             | 16—20 | 21—25 | 26—30 | 31—35 | 36—40 | 41—45 |       |
| <b>Samsø Belt—Great Belt</b> |                     |                          |                   |       |       |       |       |       |       |       |
| July—September . . . . .     | 10—14               | 5                        | 0.4               | 27    | 19    | 7     | 5     | —     | 0.4   | 59    |
|                              | 15—25               | 12                       | —                 | —     | —     | 2     | 2     | 0.8   | 0.2   | 5     |
| <b>Smålandshavet</b>         |                     |                          |                   |       |       |       |       |       |       |       |
| August . . . . .             | 12                  | 3                        | —                 | 0.7   | 2     | 3     | —     | —     | —     | 6     |
| <b>Little Belt</b>           |                     |                          |                   |       |       |       |       |       |       |       |
| July—September . . . . .     | 10—25               | —                        | —                 | —     | 1     | 2     | 1     | 1     | —     | 5     |
| <b>Sound</b>                 |                     |                          |                   |       |       |       |       |       |       |       |
| April . . . . .              | 17                  | 1                        | —                 | —     | 8     | 20    | 18    | 2     | —     | 48    |
| June—November . . . . .      | 20—31               | 12                       | —                 | —     | —     | —     | 0.2   | —     | —     | 0.2   |
| <b>Møen</b>                  |                     |                          |                   |       |       |       |       |       |       |       |
| October—November . . . .     | 15—30               | 8                        | —                 | —     | 0.2   | 0.8   | 1     | 0.5   | —     | 3     |
| <b>Bornholm</b>              |                     |                          |                   |       |       |       |       |       |       |       |
| August . . . . .             | 31—75               | 10                       | —                 | —     | 0.2   | 0.2   | —     | —     | —     | 0.4   |

**Flounder** (Table 15)

The stock of flounder of commercial size (more than 250 mm. in length) was about as sparse as in 1954 and 1955, but the stock of undersized flounder in the northern part of the Belts had improved very much (cf. Ann. Biol., XII, Table 13, p. 121). In the Sound almost no flounders were found except in a haul in April. One haul is of course insufficient for an estimation of the density of the stock but it shows that flounder were in fact present in the Sound at the depth where fishing was carried out, whereas in June, October, and November only one flounder was caught in 12 hauls. It is most likely that for most of the year the flounder in the Sound inhabits shallower waters than those fished, but of course it is not impossible that a considerable part of the stock has emigrated from the Sound for reasons unknown.

However, it may be noted that sufficient flounder remained in the Sound to support a commercial fishery throughout the year. The Danish catch of flounder from the northern part of the Sound (north of Dragør-Limhamn) was nearly 30% below that for 1955 and rather more than half the average over the last 10 years.

In 1955 the flounder stock in the northern part of the Belts consisted mostly of fish of the III and IV groups, but in 1956 the I group (the rich 1955 year-class, discovered in the coastal investigations) constituted the major part of the stock. The commercial stock in this part of the Belts will be larger in 1957.

AA. J. C. JENSEN

**Length and Age Composition of the Flounder in Gdansk Bay in 1954—1956**

(Table 16)

In continuation of the investigations into the length and age of the flounder stock (*Pleuronectes flesus*) samples were taken from trawl catches from every part of the southern Baltic. The data presented below refer only to the eastern Baltic.

The mean lengths of the fish in the Gdansk Bay catches in the years 1954—56 are shown below:—

| Year           | Mean length, cm. |
|----------------|------------------|
| 1954 . . . . . | 25.2             |
| 1955 . . . . . | 23.3             |
| 1956 . . . . . | 23.4             |

The numbers (per mille) in each length group is presented for each year in Table 16.

The numbers (per mille) of flounder of each group in Gdansk Bay catches in 1955 and 1956 are as follows:—

| Age-group | II | III | IV  | V   | VI | VII | VIII | Number of fish |
|-----------|----|-----|-----|-----|----|-----|------|----------------|
| 1955 ..   | 45 | 389 | 332 | 148 | 46 | 21  | 19   | 1161           |
| 1956 ..   | 37 | 373 | 356 | 151 | 54 | 18  | 11   | 1433           |

During the period under consideration some rejuvenation of the stock appears to have occurred, this being reflected in both mean length of the fish caught and in age composition.

SŁAWOMIR SADOWSKI

Table 16

|                               |        |    |    |    |     |     |     |      |    |    |    |    |    |    |    |    |    |    |    | Number  |
|-------------------------------|--------|----|----|----|-----|-----|-----|------|----|----|----|----|----|----|----|----|----|----|----|---------|
|                               | cm.    | 18 | 19 | 20 | 21  | 22  | 23  | 24   | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | of fish |
| 1243.....                     | 4..... |    | 7  | 20 | 45  | 67  | 105 | 111  | 92 | 79 | 71 | 37 | 37 | 21 | 19 | 18 |    | 8  | 24 | 890     |
| 5..5.19.1781 00 9 112 01..... |        |    | 14 | 42 | 87  | 119 | 145 | 150  | 53 | 43 | 32 | 26 | 14 | 9  | 6  | 4  | 3  | 9  |    | 2119    |
| 65 5.....11.....99.....       |        |    | 31 | 71 | 103 | 123 | 115 | 1057 | 75 | 65 | 44 | 27 | 16 | 8  | 8  | 4  | 4  | 8  |    | 3454    |



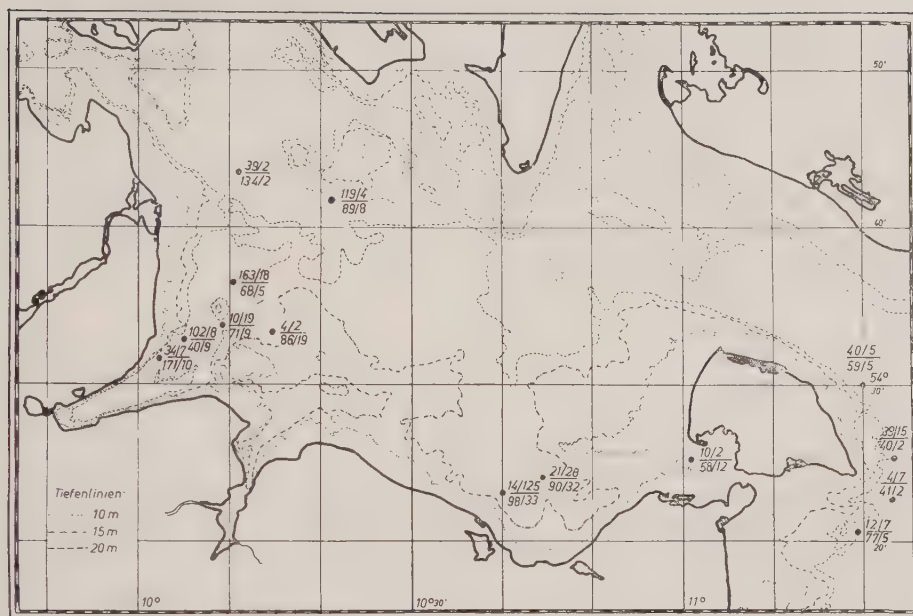


Figure 17. Catch per hour with the standard trawl in Kiel Bay and east of Fehmarn, 28. May—2. June 1956.

Numerals left of the diagonal rule = fish below 25 cm.  
Numerals right of the diagonal rule = fish above 25 cm.  
Over the line = cod and whiting. Under the line = flatfish.

### German Investigations

#### Gadidae and Flatfish caught with the Standard Trawl in May and October 1956 in the Western Baltic

(Figures 17—18; Tables 17—20)

In accordance with the recommendation of the Baltic-Belt Seas Committee in 1955, comparative fishing with the standard trawl was undertaken in 1956. In May/June (28.—2.) and October (15.—19.), hauls were made with a small fishing vessel at 13—14 stations in depths of 17—25 m. at various places in Kiel Bay and round Fehmarn. The results are given in Tables 17—20 and Figures 17—18.

##### 1. Cod

In the region investigated, the cod was more numerous in October (100 cod per hour) than in May (31). The higher numbers in October were due mainly to the appearance of a new 0-group, and also to the presence of larger quantities of I- and II-group fish; cod of more than 45 cm. in length were present in May and October in the same numbers (4—5 per hour).

In May cod larger than 25 cm. were caught mainly in the Hohwacht Bay. On some occasions the rate of fishing was more than 100 fish per hour; 90% of the catch belonged to the III and IV

groups. In October, the proportion of the larger sized fish decreased, because of the increase in the numbers of small fish of age-group II. Large catches of cod were made in Eckernförde Bay also.

##### 2. Whiting

In May the average rate of fishing was 30 fish per hour and in October 90.

In May most of the fish belonged to the I group, with a length of 10—15 cm. No whiting of more than 25 cm. in length were present. Larger catches of whiting (100—120 per hour) were obtained only in the trough south of Vejsnäs-Flat and in Eckernförde Bay.

In October the stock consisted mainly of fish of the 0- and I-groups, with lengths up to 25 cm. On the other hand, fish of the III and IV groups of more than 25 cm. in length were very rare (1.2 per hour). The best hauls were made in the Hohwacht Bay and near Schleimünde.

##### 3. Plaice

In May catches were of about equal numbers in all localities, the average being only 2.1 fish per hour, with lengths between 23 and 39 cm. These fish belonged to the III and IV group. The higher average of 7.3 fish per hour achieved in October was due mainly to two good hauls of 35 and 37

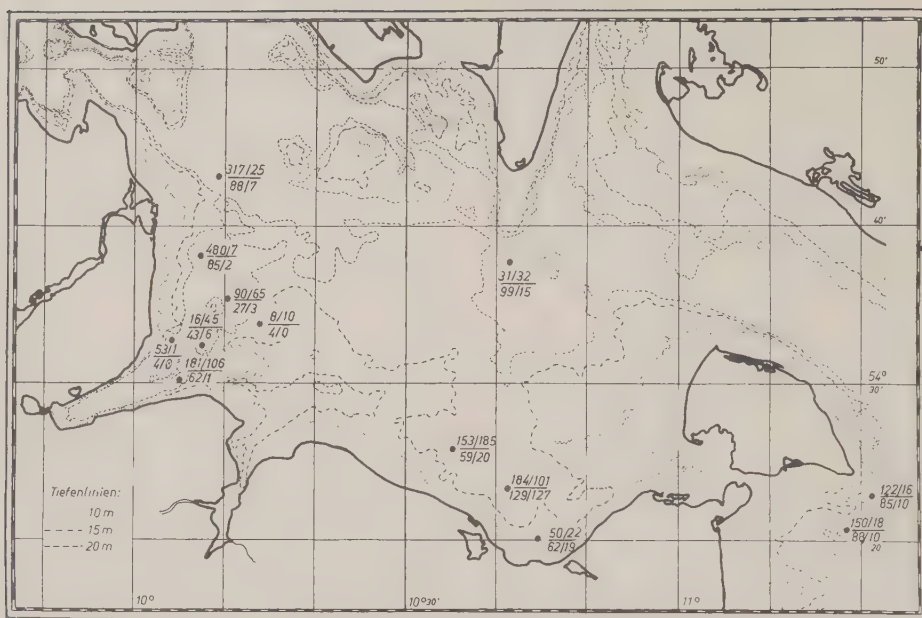


Figure 18. Catch per hour with the standard trawl in Kiel Bay and east of Fehmarn, 15.—19. October 1956.

Numerals left of the diagonal rule = fish below 25 cm.  
Numerals right of the diagonal rule = fish above 25 cm.  
Over the line = cod and whiting. Under the line = flatfish.

fish per hour in Hohwacht Bay. These plaice, however, belonged mainly to the I group, with lengths of 16 to 27 cm.

#### 4. Flounder

In both May and October flounder were caught, the rate being only 0.7 per hour, of length 27—36 cm.

Table 17. Numbers of cod, whiting, plaice, flounder, and dab caught per hour with the standard trawl in the western Baltic

(Average of 14 stations, May—June 1956)

| Length (cm.) | Cod  | Whiting | Plaice | Flounder | Dab  |
|--------------|------|---------|--------|----------|------|
| 9—10 .....   | 0.7  | 8.0     | —      | —        | —    |
| 11—15 .....  | 7.0  | 20.9    | —      | —        | 0.4  |
| 16—20 .....  | 4.2  | 1.3     | —      | —        | 37.2 |
| 21—25 .....  | 1.6  | 0.1     | 0.4    | —        | 35.5 |
| 26—30 .....  | 4.8  | —       | 0.6    | 0.2      | 11.0 |
| 31—35 .....  | 6.0  | —       | 0.8    | 0.5      | 5.5  |
| 36—40 .....  | 1.8  | —       | 0.3    | —        | 1.4  |
| 41—45 .....  | 0.8  | —       | —      | —        | —    |
| 46—50 .....  | 0.5  | —       | —      | —        | —    |
| 51—55 .....  | 0.5  | —       | —      | —        | —    |
| 56—60 .....  | 0.8  | —       | —      | —        | —    |
| 61—65 .....  | 1.3  | —       | —      | —        | —    |
| 66—70 .....  | 0.3  | —       | —      | —        | —    |
| 71—75 .....  | 0.3  | —       | —      | —        | —    |
| 76—80 .....  | 0.1  | —       | —      | —        | —    |
| 92 .....     | 0.1  | —       | —      | —        | —    |
| Total .....  | 30.8 | 30.3    | 2.1    | 0.7      | 91.0 |

Table 18. Numbers of various age-groups of cod, whiting, plaice, flounder, and dab caught per hour with the standard trawl in the western Baltic

(Average of 14 stations, May—June 1956)

| Age-group   | Cod  | Whiting | Plaice | Flounder | Dab  |
|-------------|------|---------|--------|----------|------|
| I .....     | 10.6 | 29.9    | —      | —        | —    |
| II .....    | 7.7  | 0.3     | —      | —        | 66.3 |
| III .....   | 5.8  | 0.1     | 0.7    | 0.1      | 15.3 |
| IV .....    | 2.9  | —       | 0.9    | 0.3      | 6.3  |
| V .....     | 1.0  | —       | 0.5    | 0.3      | 2.1  |
| VI+ .....   | 2.8  | —       | —      | —        | 1.0  |
| Total ..... | 30.8 | 30.3    | 2.1    | 0.7      | 91.0 |

Table 19. Numbers of cod, whiting, plaice, flounder, and dab caught per hour with the standard trawl in the western Baltic

(Average of 13 stations, October 1956)

| Length (cm.) | Cod   | Whiting | Plaice | Flounder | Dab  |
|--------------|-------|---------|--------|----------|------|
| 6—10 ....    | 19.9  | 47.0    | —      | —        | 2.5  |
| 11—15 ....   | 10.3  | 29.6    | 0.1    | —        | 7.4  |
| 16—20 ....   | 5.9   | 5.2     | 1.3    | —        | 35.3 |
| 21—25 ....   | 19.6  | 7.0     | 3.5    | —        | 15.0 |
| 26—30 ....   | 11.0  | 1.0     | 1.4    | 0.4      | 2.2  |
| 31—35 ....   | 10.1  | 0.2     | 0.8    | 0.3      | 0.2  |
| 36—40 ....   | 13.3  | —       | 0.1    | —        | —    |
| 41—45 ....   | 5.6   | —       | 0.1    | —        | —    |
| 46—50 ....   | 1.8   | —       | —      | —        | —    |
| 51—55 ....   | 1.5   | —       | —      | —        | —    |
| 56—60 ....   | 0.5   | —       | —      | —        | —    |
| 61—65 ....   | 0.2   | —       | —      | —        | —    |
| 66—70 ....   | 0.2   | —       | —      | —        | —    |
| 90 .....     | 0.1   | —       | —      | —        | —    |
| Total .....  | 100.0 | 90.0    | 7.3    | 0.7      | 62.6 |

Table 20. Number of various age-groups of cod, whiting, plaice, flounder, and dab caught per hour with the standard trawl in the western Baltic

(Average of 13 stations, October 1956)

| Age-group   | Cod   | Whiting | Plaice | Flounder | Dab  |
|-------------|-------|---------|--------|----------|------|
| 0 .....     | 30.0  | 56.8    | 0.1    | —        | —    |
| I .....     | 36.4  | 25.0    | 5.5    | —        | 8.8  |
| II .....    | 23.4  | 7.0     | 0.9    | 0.2      | 48.7 |
| III .....   | 7.3   | 1.0     | 0.7    | 0.4      | 3.8  |
| IV .....    | 2.0   | 0.2     | 0.1    | 0.1      | 1.3  |
| V .....     | 0.8   | —       | —      | —        | —    |
| VI .....    | —     | —       | —      | —        | —    |
| VII .....   | 0.1   | —       | —      | —        | —    |
| Total ..... | 100.0 | 90.0    | 7.3    | 0.7      | 62.6 |

These belonged to age-groups III to V; most of them were caught in the Fehmarn Belt and Hohwacht Bay.

#### 5. Dab

The dab was the flatfish most frequently encountered. It was caught at nearly every station, averaging up to 91 fish in May and 63 in October. In May dabs were more numerous in the eastern part of Kiel Bay than elsewhere (over 100 per hour). Most of the fish belonged to the II and III groups, with length of 16 to 30 cm.

In October the average catch on these grounds had fallen to 39 dabs per hour. The III group and length-groups of 16-25 cm. were predominant.

#### 6. Drepanopsetta platessoides

A small number of this species was caught at various places, especially south of Langeland (15 fish per hour) and east of Fehmarn (9 fish) in October. With lengths from 22 to 28 cm. they belonged mostly to age-group II (1954 year-class).

R. KÄNDLER

### Swedish Investigations on Flatfish

In 1956 trawling for demersal fish was undertaken in the southern Baltic on only three days in March (21.—23.). The investigations, which covered about 7 trawling hours, were made in areas A, C, and D (see Ann. Biol., XII, p. 122). The same vessel and gear were used as in 1955.

In general, the catches of flatfish were smaller than in 1955, in consequence perhaps of the extremely low water temperatures in the early part of 1956. The average number of fish caught per hour was 46.5 plaice, 5.3 flounder, and 3.1 dab.

The decrease in numbers is largest for flounder, especially in area D, where the 1955 hauls gave 50.1 per hour (as against 5.3). Possibly the low temperature of the bottom waters may have affected the general behaviour of this species in early spring, the spawning migration in particular.

The stock of plaice was still large, however. The strong 1952 year-class, now about four years old, predominated as it did in 1955. The 1953 year-class is obviously of more moderate size. This trend is common for the three areas investigated.

G. OTTERLIND

#### Eel

#### Forecast of the Yield of the Silver-Eel Fishery

As usual, a forecast was published, based on the surface temperature of the water in the summer. As the temperature was low, especially in August, the yield was expected to be ca. 5% lower than normal. According to the monthly returns reported to the Ministry, the yield was very small in many parts of the Belts and the western Baltic; this was due in part to the stormy weather. In spite of this, however, the statistics showed that the yield of the silver-eel fishery as a whole was relatively high —15% higher than the average for the last 25 years and 7% higher than the average for the last 10 years. No doubt more small silver-eels have been caught since the size limit was withdrawn on 1. December 1952. The fresh arrangements for the collection of the fishery statistics in 1951/52 may also have resulted in some differences in the figures for the catch.

The incidence of the tumor disease was on the whole about as frequent as in 1955. At Bornholm the frequency seems to have been less.

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#### Tagging of Silver Eels

The tagging experiments were continued at Åhus on the eastern coast of Scania, where 550 eels were tagged.

Up to 1. April 1957, a total recapture of about 45% is reported. About 9% of the eels liberated were recaptured in Danish waters; there is also one return from Rügen.

S. SAHLIN

## Comité Atlantique

### INTRODUCTION

Les contributions au présent rapport ont été apportées par:—

#### Hydrologie et Plancton

M. L. FURNESTIN: Chaetognathes et zooplancton du secteur atlantique marocain.

J. M. PÉRÈS: Nouvelles plongées du Bathyscaphe F. N. R. S. III.

J. LE DANTEC: Quelques observations relatives à l'action du froid sur les huîtres.

J. FURNESTIN

### LES CONDITIONS DE MILIEU

#### Hydrologie et Plancton

##### Chaetognathes et Zooplancton du Secteur Atlantique Marocain

Notre examen a porté non seulement sur les récoltes trimestrielles de sept années consécutives, le long de 1,200 km. de côtes, mais encore sur des échantillons de provenance diverse — Atlantique et Méditerranée — qui ont servi de termes de comparaison et ont contribué à développer certaines de nos conclusions.

1°— L'analyse quantitative de ce matériel a permis de déterminer la répartition du zooplancton suivant des modalités qu'il partage parfois avec celles d'autres régions mais qui lui sont souvent propres.

a) L'abondance du plancton diminue de la côte vers le large, la primauté de la zone eulitorale ne s'effaçant qu'assez rarement aux saisons les moins chaudes — hiver et printemps.

b) Cette abondance augmente du nord au sud, compte tenu de quelques irrégularités saisonnières.

c) Les plus fortes variations quantitatives s'observent dans le secteur le plus riche — celui du sud — et les plus faibles dans le plus pauvre — celui du nord.

d) Les zones de transition (et de contraste) de Mazagan et surtout du Cap Ghir, où se mélangent des eaux de température et de salure différentes, sont particulièrement riches.

e) La saison la mieux pourvue en zooplancton est l'automne, suivi de l'hiver, puis du printemps, l'été étant la saison du minimum.

2°— L'influence sur le plancton des facteurs hydrologiques est manifeste. Les eaux ascendantes, surtout, jouent un rôle important dans son cycle annuel.

a) Au printemps, la montée des eaux profondes (de pente) se développant progressivement du sud au nord, appauvrit la zone côtière, sauf dans sa partie septentrionale encore peu affectée.

b) En été, l'appauvrissement s'accroît et se généralise avec l'extension et l'épanouissement en surface des eaux ascendantes.

c) Mais en automne, celles-ci se résorbent partiellement et se mélangent avec les eaux du large drainées vers la côte; il s'en suit un très grand enrichissement qui se prolonge jusqu'en hiver.

d) Au cours de ce dernier, les conditions hydrologiques s'équilibrent, les facteurs favorables se dégradent lentement et la quantité de zooplancton commence à diminuer.

e) Pour expliquer ces phénomènes nous avons fait appel aux hypothèses de l'"exclusion animale" et de l'"eau rouge". Les eaux ascendantes entraîneraient la raréfaction du zooplancton par un apport massif de sels nutritifs déclenchant une excessive floraison de phytoplancton, cause majeure de l'"exclusion animale".



A cette action s'ajouterait en été celle des températures trop élevées des eaux du large envahissant la zone côtière et recouvrant, sans se mélanger à elles, les eaux d'origine profonde.

En automne, le renversement de la situation hydrologique provoque un brassage des eaux de diverse nature et fait disparaître les causes d'"exclusion animale". C'est pourquoi les secteurs (Ghir) et les saisons (automne) où de tels brassages sont les plus forts présentent la plus grande abondance de zooplancton.

3°— Une liste des espèces planctoniques du Maroc a été dressée à partir de nos déterminations et d'après les résultats de croisières antérieures.

4°— Divers éléments de cette faune se distinguant, soit par leur abondance, soit par leur comportement, ont retenu plus spécialement notre attention; ce sont les Siphonophores, les Appendiculaires, les Thaliacés, les Cladocères, les Chaetognathes.

L'étude des quatre premiers de ces groupes a fourni des données nouvelles sur l'écologie des formes du secteur marocain.

5°— Pour les Chaetognathes, l'analyse a été poussée plus loin.

a) Leur systématique a été révisée dans certains cas et un ensemble de précisions d'ordre morphologique et écologique réuni. Par exemple,

*Sagitta friderici*, espèce jusqu'ici peu connue, a pu être identifiée dans de nombreux secteurs à la suite de nos recherches.

*Sagitta bipunctata* et *Sagitta californica* étaient tenues pour des espèces différentes. Nous avons rayé de la nomenclature la dernière qui n'est que le stade adulte de la première.

Résultats analogues pour *Sagitta lyra*, dont les stades juvéniles et adultes faisaient l'objet de dénominations distinctes.

De même, *Sagitta enflata* a une plus grande unité que ne le pensaient les auteurs. L'existence de plusieurs cycles sexuels a pu être démontrée pour les spécimens de la zone intertropicale; il est probable que cela a été à l'origine de l'identification, dans les océans Indien et Pacifique, de différentes espèces et sous-espèces qui, en fait, n'existent pas et doivent donc disparaître de la liste des Chaetognathes.

En revanche, la révision des formes à crochets serrulés a abouti à la reconnaissance de trois espèces au sein de *Sagitta serrato-dentata*.

b) Un classement des Chaetognathes de l'Atlantique a été établi. Six groupes, dont les types sont: *S. friderici*, *S. bipunctata*, *S. serrato-dentata*, *S. hexaptera*, *S. lyra*, *S. enflata*, ont été constitués en fonction des ressemblances morphologiques et biologiques présentées par les espèces. Ces espèces, de plus, se remplacent l'une l'autre dans chaque groupe du nord au sud de l'Atlantique.

c) Une clef dichotomique de ces Chaetognathes a été donnée.

6°— Les rapports entre le comportement des formes planctoniques et les conditions de milieu de la mer marocaine ont été dégagés. Déjà perceptible sur des groupes entiers, l'influence des facteurs hydrologiques l'est plus encore sur des espèces déterminées. Elle conduit à distinguer diverses catégories de formes bien adaptées aux eaux de différente nature et pouvant être utilisées comme leurs indicateurs.

Parmi les Siphonophores, les Appendiculaires, les Salpes, les Cladocères et les Chaetognathes nous avons pu reconnaître ainsi:

- des formes caractéristiques des eaux du large et dont la vaste répartition fait d'excellents indicateurs aussi bien dans la province boréale que dans la province subtropicale de l'Océan;
- des formes des eaux côtières, d'une répartition géographique relativement limitée, qui ne leur permet de caractériser qu'une région étroite;
- des formes des eaux profondes signalant en surface l'épanouissement de courants ascendants et qui, dans leur extension, sont intermédiaires entre les formes précédentes.

Ainsi se trouve ouverte une première liste d'indicateurs planctoniques pour la mer marocaine, que des recherches portant sur d'autres groupes du zooplancton pourront heureusement compléter.

Tels sont les faits essentiels — souvent originaux — que l'étude quantitative et qualitative du plancton nous a fournis dans les domaines de la systématique, de la morphologie et de l'écologie pour les espèces d'une région encore mal connue sous cet aspect.

M.-L. FURNESTIN

### Nouvelles Plongées du Bathyscaphe F.N.R.S. III

Au cours de l'été 1956, le Bathyscaphe F.N.R.S. III de la Marine Nationale Française, piloté par le Commandant G. HOUOT, a fait, sous l'égide du Centre National de la Recherche Scientifique des recherches de caractère biologique au large du Portugal.

Six plongées ont été effectuées, de 610 à 2,200 mètres (J. M. PÉRÈS: trois; M. RUIVO: deux; J. PICARD: une).

Un travail récent<sup>1</sup> indique les résultats des observations qui peuvent être brièvement résumées comme suit:—

a) La nappe d'eau, d'origine méditerranéenne a été reconnue, mais paraît pénétrer assez difficilement dans la tête du Cañon de Setubal.

b) Les courants au voisinage du fond sont vifs dans le cañon, et paraissent se diriger suivant le sens descendant.

c) Le plancton est plus riche et plus varié dans les eaux du cañon que sur la pente en dehors du cañon. Il paraît y avoir un étagement assez net des éléments planctoniques. En surface, le micro-plancton est toujours riche jusque vers 50 mètres et diminue progressivement jusqu'à 130—140 mètres.

Il s'y ajoute, surtout dans le cañon, des éléments macro-planctoniques, toujours plus abondamment dans les cinquante premiers mètres. De 130 à 300—400 mètres, micro-plancton et macro-plancton sont peu denses; de 400 à 800 mètres environ, le plancton redevient riche (zone des grands *Solmissus* et des petits *Myctophidae*); de 800 à 1,500 mètres, le peuplement s'appauvrit.

d) Le benthos des substrats meubles paraît plus riche dans l'étage meso-bathyal que dans l'étage épi-bathyal. A 1680 mètres de profondeur au débouché du cañon, on a observé une très belle faune, principalement à base d'Anthozoaires. Les poissons sont assez nombreux, notamment: *Halosaurus johnsonianus*. Les substrats durs, quand ils existent, sont pratiquement dépourvus d'épifaune.

J. M. PÉRÈS

### Quelques Observations relatives à l'Action du Froid sur les Huîtres

(Tableau 1)

Le mois de février 1956 fut particulièrement rigoureux à Arcachon. Nous donnons dans le tableau ci-dessous les températures de l'air (station météorologique d'Arcachon près de la plage) et de l'eau de mer (station fixe à l'extrémité de la jetée d'Eyrac).

Dans l'ensemble des chenaux du Bassin d'Arcachon la salinité demeura relativement élevée.

Ainsi, le 15 février, à basse-mer, les salinités ont varié de 24.9 à 28.6‰.

Des blocs de glace étaient charriés par le courant du jusant et se déposaient à l'étable sur les parcs et les collecteurs. Ils étaient soulevés par le courant de flot et emportaient parfois des huîtres.

Il y eut cependant très peu de mortalité sur parcs.

Elle fut inexistante lorsque les coquilles adhéraient parfaitement au sol.

Elle fut sensible sur des lots récemment mis en place et en particulier lorsqu'il s'agissait de sujets non adaptés à une émergence prolongée.

Les huîtres portugaises de plus de 3 ans souffrirent plus que les jeunes: les parties crayeuses et poreuses de la coquille éclatèrent ou acquirent une extrême friabilité.

Sur les huîtres plates l'action du froid se manifesta par un relâchement du muscle adducteur.

Par contre nous avons constaté une forte mortalité sur les "pignots" et dans les caisses ostréophiles.

Sur les tuiles les naissains d'huîtres plates n'ont résisté qu'en très faible pourcentage. Les jeunes gryphées n'ont apparemment pas souffert, mais l'enduit calcaire s'est désagrégé et s'est détaché par plaques. Les ostréiculteurs ont commencé le détroquage dès le début du mois de mars. La récolte fut ainsi sauvée en partie. Il ne semble pas que l'exposition des collecteurs ait joué un rôle important dans la plus ou moins bonne tenue de l'enduit; la composition du mortier en fut surtout responsable c. a. d. les tuiles neuves en particulier furent presque entièrement dégarnies.

En Gironde, où les eaux étaient plus douces, les naissains de gryphées ont disparu en forte proportion. Il est impossible d'établir une carte de la

<sup>1</sup>) Bull. Inst. Océanogr. Monaco, 1952, 1957.

Tableau 1. Températures relevées en février 1956  
à Arcachon

| Dates    | Air     |         | Eau de Mer |         |
|----------|---------|---------|------------|---------|
|          | Minimum | Maximum | Minimum    | Maximum |
| 1 .....  | + 4     | + 11    | + 6        | + 7     |
| 2 .....  | - 7     | + 8     | + 6.5      | + 7     |
| 3 .....  | - 9     | + 2     | + 6        | + 6     |
| 4 .....  | - 5.5   | 0       | + 4        | + 4     |
| 5 .....  | - 4     | + 3     | + 2.5      | + 3     |
| 6 .....  | + 2     | + 4     | + 3        | + 3     |
| 7 .....  | + 4     | + 10    | + 2.5      | + 4     |
| 8 .....  | - 4     | + 13    | + 3        | + 4.5   |
| 9 .....  | - 2     | + 6     | + 3        | + 3     |
| 10 ..... | - 9     | + 6     | + 2        | + 2     |
| 11 ..... | - 8     | - 3     | + 1        | + 1.5   |
| 12 ..... | - 5     | - 4     | + 1        | + 1     |
| 13 ..... | - 1     | + 2     | + 0.5      | + 0.5   |
| 14 ..... | - 3     | + 6     | 0          | 0       |
| 15 ..... | - 10    | + 1     | + 1        | + 1     |
| 16 ..... | - 3     | + 5     | + 0.5      | + 1     |
| 17 ..... | - 4     | + 4     | + 1        | + 1     |
| 18 ..... | - 2     | + 5     | 0          | + 1     |
| 19 ..... | - 3     | + 2     | - 2        | + 1     |
| 20 ..... | - 7     | + 3     | - 1        | - 1     |
| 21 ..... | - 6     | + 2     | - 1        | 0       |
| 22 ..... | - 8     | + 1     | - 1        | - 1     |
| 23 ..... | - 10    | + 4     | - 2        | - 1     |
| 24 ..... | - 6     | + 3     | - 1        | - 1     |
| 25 ..... | + 1     | + 11    | - 1        | 0       |
| 26 ..... | - 4     | + 5     | + 1        | + 2     |
| 27 ..... | - 3     | + 4     | 0          | + 1     |
| 28 ..... | - 5     | + 10    | 0          | + 2     |
| 29 ..... | + 2     | + 10    | + 1        | + 2     |

Nous avons suivien janvier et février l'évolution de la température et de la salinité dans le grand réservoir ostréicole de Gujan-Mestras. Pendant la période des grands froids, du 15 au 25 février la salinité était de l'ordre de 23 à 24‰.

Le 15 février la température de l'air devant le magasin de l'expédition passait par les extrêmes suivants: —

à 8 heures,  $-17^{\circ}\text{C.}$ ; à 10 heures,  $-14^{\circ}\text{C.}$ ; à 15 heures,  $+12^{\circ}\text{C.}$  Une épaisseur de glace de 5 centimètres recouvrait le plan d'eau. Elle atteignait 7 cm. le 22 février.

L'eau de mer conservait une température variant de  $1^{\circ}$  à l'écluse à  $2^{\circ}$  au fond du réservoir. Le 26 février l'eau d'alimentation accusait une température de  $+4^{\circ}$ . Elle ne put soulever la glace, dont une nouvelle couche se superposa à la première.

Après le dégel l'eau de surface fut évacuée et remplacée par de l'eau puisée au fond du chenal d'alimentation par pompage à haute mer.

Les dosages des prélèvements effectués le 2 mars dans le réservoir donnaient en effet les résultats suivants: —

Surface,  $S^0_{00} < 7$ ; fond (1 mètre),  $S^0_{00} > 22$

Il est intéressant de noter que les huîtres immergées, portugaises ou plates de 3 ans n'ont pas souffert.

Par contre anguilles et muges sont morts.

J. LE DANTEC

mortalité: Un rocher d'huîtres bien vivaces voisine avec une pierre émaillée de taches blanches formées par les valves inférieures des jeunes huîtres dont la coquille supérieure est tombée.

Dans les dépôts et dégorgeoirs il n'y eut de dégâts que lorsque les huîtres furent remuées.

# Gadoid Fish

## INTRODUCTION

Contributions to this report have been received from the following countries:—

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## YOUNG STAGES

### Greenland

#### Cod Fry and Small Cod in Coastal Waters and on the Offshore Banks of West Greenland, 1956

(Figures 1-3; Tables 1-2)

#### Occurrence of cod eggs

The numbers of cod eggs caught with the 1 m. stramin net by the "Adolf Jensen" from February to June are given in Table 1. The positions of the stations are shown in Figure 1. Six stations are situated well inside Godthåb Fjord, one in the entrance to the fjord, and one in the inshore waters south of the fjord.

From previous investigations it is known that Station 4 is on a spawning ground for cod, which is the reason why the largest numbers of cod eggs were taken at this station. It appears from the numbers of cod eggs caught in different months at this station that in February the spawning was poor. In April and in the first half of May spawning was at its height. At Stations 5 and 6 there was

Table 1

| Station  | 1   | 2   | 3   | 4      | 5      | 6      | 7  | 8  |
|----------|-----|-----|-----|--------|--------|--------|----|----|
| February |     |     |     |        |        |        |    |    |
| 1.—15.   | —   | —   | —   | —      | —      | —      | —  | —  |
| 15.—28.  | —   | —   | —   | 30     | —      | —      | 0  | —  |
| March    |     |     |     |        |        |        |    |    |
| 1.—15.   | —   | —   | —   | 1,600  | —      | —      | —  | 0  |
| 15.—31.  | —   | —   | —   | —      | —      | —      | —  | —  |
| April    |     |     |     |        |        |        |    |    |
| 1.—15.   | 30  | 352 | 60  | 45,000 | —      | 65     | 0  | —  |
| 15.—30.  | —   | —   | —   | —      | —      | —      | 15 | 0  |
| May      |     |     |     |        |        |        |    |    |
| 1.—15.   | —   | 280 | 260 | 40,000 | 17,000 | 10,000 | —  | —  |
| 15.—31.  | 180 | —   | —   | 8,000  | —      | —      | 15 | 10 |
| June     |     |     |     |        |        |        |    |    |
| 1.—15.   | —   | —   | —   | —      | —      | —      | 29 | —  |
| 15.—30.  | —   | —   | —   | —      | —      | —      | —  | —  |

evidence of some spawning in May but it was much less than at Station 4 and the spawning at Stations 1, 2, and 3 appears to be still less.

At Station 7, in the entrance to the Godthåb Fjord no eggs were found before the end of April



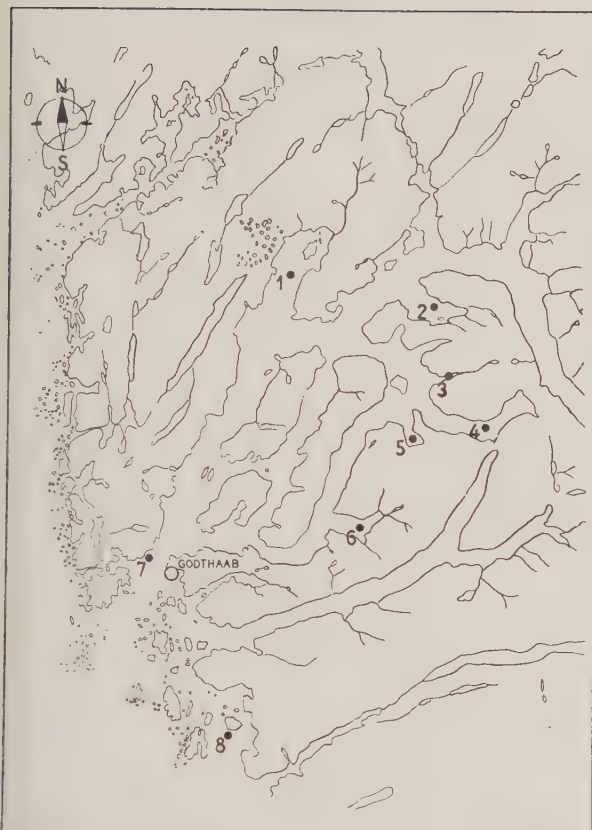


Figure 1. The positions of the stations at which cod eggs were taken in 30-minute hauls with a 1 m. stramin net by the "Adolf Jensen" with 50–100 m. of wire out.

and then only in small numbers. On 16. May and 7. June also a few eggs were taken at this station. These eggs had probably been carried out of the fjord by the surface current. At Station 8 no eggs were caught in April and only 10 were taken at the end of May.

The numbers of cod eggs taken in Godthåb Fjord this year were very poor compared with the numbers obtained in previous years.

On 23. April 4 cod eggs were caught in the middle of Fylla Bank. On 7. May 5 cod eggs were caught in a haul made between the bank and the coast. On 5. June three hauls with the 1 m. stramin net, one between the bank and the coast, one in the middle of the bank, another on the western edge, gave 0, 1, and 35 cod eggs respectively. The comparatively large number of cod eggs obtained off the western edge of the bank is not surprising, in view of the fact that a cod spawning ground is located there.

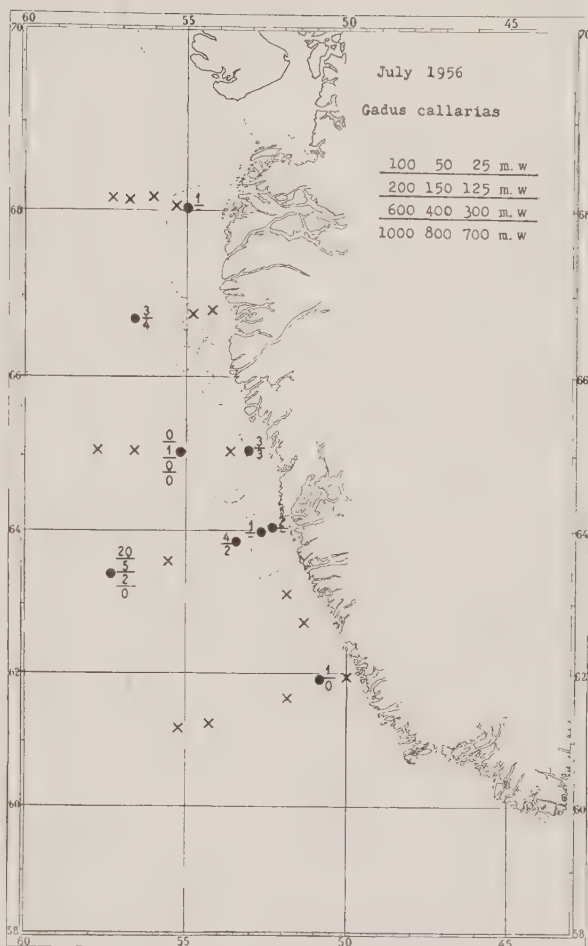


Figure 2. Catches of cod larvae in 30-minute hauls with a 2 m. stramin net by the "Dana".

#### Occurrence of cod fry

The numbers of larval cod caught by the "Dana" with the 2 m. stramin net in June are shown in Figure 2. The numbers are the smallest in all the six years that the hauls with the 2 m. stramin net have been made.

The most cod larvae taken in a half-hour haul was 20, at a station west of Fylla Bank in 63°25' N., 57°20' W. All the other hauls yielded less than 5, and on many stations no cod fry were taken at all.

The catch of 20 cod larvae at the westernmost station indicate a west-going drift carrying cod fry from the spawning grounds on the western slopes of the Greenland Banks towards Labrador. It is worth mentioning that in 1955 also cod fry were caught in the same westerly position as in 1956.

The sparse occurrence of both eggs and fry of cod suggests that the 1956 year-class will be very poor.

Table 2

| Sample | Position           | Date<br>1956 | Gear            | Number of fish     |
|--------|--------------------|--------------|-----------------|--------------------|
| a      | 66°55'N., 53°40'W. | 16. 7.       | seine           | 787                |
| b      | 64°21'N., 50°22'W. | 10. 6.       | "               | 276                |
| c      | 63°17'N., 51°05'W. | 28. 8.       | "               | 456 (ages determ.) |
| d      | 63°53'N., 51°28'W. | 10. 2.       | shrimp<br>trawl | 59 " "             |
| e      | " "                | 10. 3.       | "               | 65 " "             |

## Occurrence of small cod of age-groups I, II, and III

Small cod were taken, in rather small numbers, in hauls with the fine-mesh seine as well as with the shrimp trawl. The details of the catches are given in Table 2 and the length frequencies are shown in Figure 3. The II and III group were present in the catches c, d, and e.

The experience of many years past, that small cod of the III group are much more difficult to catch with the seine than cod of the I and II groups, together with direct observation of the occurrence in several inshore localities of large shoals of small cod about the same size as cod of the III group, suggests that the 1953 year-class is the most important among the younger cod.

The average lengths of small cod of age-groups II and III were as follows:—

| Station | Date         | II       | III      |
|---------|--------------|----------|----------|
| d ..... | 10. February | 18.0 cm. | 27.5 cm. |
| e ..... | 10. March    | 18.6 cm. | 28.6 cm. |

PAUL M. HANSEN

## Norwegian Skagerak Coast

## Cod, Whiting, and Pollack

(Tables 3-7)

The usual experimental fishing with a shore seine in the littoral region has been continued.

In the fjords between Kragerø and Mandal 78 hauls were made (see Table 3).

Table 3

|                              | Cod<br>0-group | Whiting<br>0-group | Pollack<br>0-group |
|------------------------------|----------------|--------------------|--------------------|
| 1917-29 .....                | 20.1           | 14.9               | 23.1               |
| 1930-39 .....                | 7.2            | 16.3               | 8.3                |
| 1940-49 <sup>1</sup> ) ..... | 4.7            | 29.6               | 8.8                |
| 1950 .....                   | 4.2            | 19.1               | 3.0                |
| 1951 .....                   | 1.9            | 18.2               | 2.6                |
| 1952 .....                   | 8.1            | 26.2               | 4.1                |
| 1953 .....                   | 14.7           | 12.4               | 2.6                |
| 1954 .....                   | 9.7            | 17.7               | 6.7                |
| 1955 .....                   | 17.7           | 24.9               | 12.5               |
| 1956 .....                   | 9.8            | 25.4               | 7.7                |

In the fjords near Langesund 11 hauls were made in 1956. The results are shown in Table 4.

Table 4

|           |          | Cod<br>0-group | Whiting<br>0-group | Pollack<br>0-group |
|-----------|----------|----------------|--------------------|--------------------|
| 1953 .... | 11 hauls | 49.1           | 35.9               | 2.1                |
| 1954 .... | 11 hauls | 51.7           | 9.2                | 3.7                |
| 1955 .... | 11 hauls | 48.7           | 1.4                | 5.7                |
| 1956 .... | 11 hauls | 27.6           | 16.8               | 4.1                |

The results from Oslo Fjord outside Drøbak are given in Table 5.

Table 5

|                              | Cod<br>0-group | Whiting<br>0-group | Pollack<br>0-group |
|------------------------------|----------------|--------------------|--------------------|
| 1936-1939 .....              | 50.2           | 9.6                | 4.5                |
| 1940-49 <sup>1</sup> ) ..... | 33.5           | 38.0               | 6.7                |
| 1950 .....                   | 14.2           | 16.7               | 3.2                |
| 1951 .....                   | 3.9            | 6.1                | 2.6                |
| 1952 .....                   | 16.8           | 31.2               | 5.5                |
| 1953 .....                   | 16.9           | 10.3               | 1.3                |
| 1954 .....                   | 9.2            | 7.3                | 3.5                |
| 1955 .....                   | 27.0           | 28.6               | 11.2               |
| 1956 .....                   | 4.2            | 17.6               | 2.5                |

The results for the inner part of the Oslo Fjord are given in Table 6.

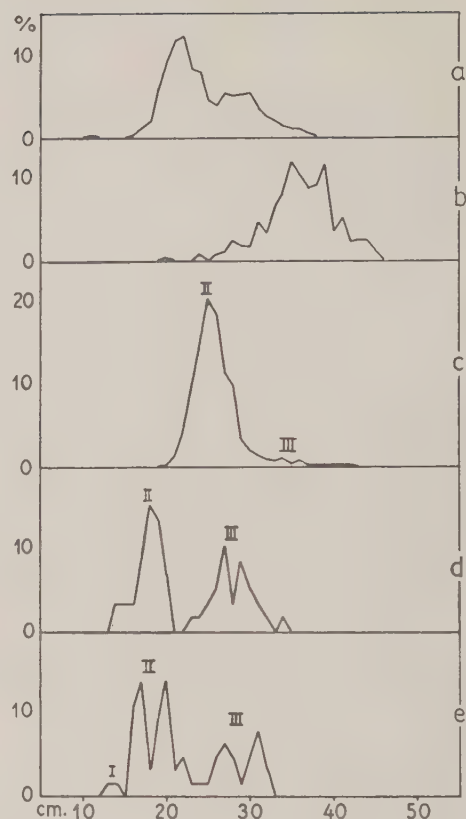


Figure 3. Length frequencies of small cod, age-groups I, II, and III.

Table 6

|                             | Cod<br>0-group | Whiting<br>0-group | Pollack<br>0-group |
|-----------------------------|----------------|--------------------|--------------------|
| 1936—39 .....               | 14.3           | 5.8                | 3.8                |
| 1940—49 <sup>1)</sup> ..... | 2.6            | 7.4                | 0.7                |
| 1950 .....                  | 0.04           | 1.0                | 0.1                |
| 1951 .....                  | 0              | 1.5                | 0.7                |
| 1952 .....                  | 0              | 0.6                | 1.7                |
| 1953 .....                  | 0              | 0.2                | 0.6                |
| 1954 .....                  | 0.17           | 0.1                | 2.3                |
| 1955 .....                  | 1.3            | 0.65               | 2.8                |
| 1956 .....                  | 0.12           | 1.16               | 0.24               |

<sup>1)</sup> The war-time figures are incomplete. The few hauls made in 1940—44 are not included.

Table 7

|            | Cod<br>per trap | Average    | Cod<br>per trap |
|------------|-----------------|------------|-----------------|
| 1921—29 .. | 70              | 1952 ..... | 85              |
| 1930—39 .. | 63              | 1953 ..... | 80              |
| 1940—49 .. | 91              | 1954 ..... | 115             |
| 1950 ..... | 101             | 1955 ..... | 66              |
| 1951 ..... | 87              | 1956 ..... | 53              |

that the method used (chromatography) makes it possible to distinguish different populations. So far, material from the Skagerak, northern Norway, and the Gulf of Bothnia has been examined.

ALF DANNEVIG

As regards the cod, the strength of the 1956 year-class on the Skagerak coast is normal. The numbers in the outer part of the Oslo Fjord are relatively low. In the inner part of the fjord 0-group cod are very scarce. It is evident that the contamination of the inner fjord by the sewage from Oslo is more than, at any rate, the early spring spawners can tolerate. The high mean value for 1936—39 is occasioned by the very rich 1938 year-class. In that year the sea water in the fjord had been completely renewed. As for the whiting and pollack, the strength of the 0-group in 1956 is normal.

The experimental trap fishery for older cod yielded 53 cod per trap.

It is evident from Table 7 that this number is low.

The hatching of cod fry was hindered by extremely low temperature in the sea; it was impossible to obtain live spawners.

Laboratory experiments were undertaken to elucidate the influence of temperature on the formation of zones in scales and otoliths.

0-group cod from the littoral region were kept in aquaria from 17. October. The data obtained have not yet been worked out in detail, but the results seem to correspond with those obtained last year.

The following conclusions were arrived at:—

- Narrow sclerites are formed when the sea temperature is high.
- Narrow sclerites are also formed at low temperatures in slow-growing individuals.
- Wide sclerites are formed at low temperatures in medium and quick growers.

Chemical analysis revealed that the formation of organic opaque material was highest at 4°C.—the lowest temperature at which experiments were conducted.

Chemical analysis of the proteins of cod from different waters has been continued. It is evident

## Danish Waters

### Cod

**Kattegat.** The number of cod obtained per 1 hour's fishing with the cod trawl from S/S "Biologen" is stated in the following table. Since the 0-group cod do not appear in the catches until after about 1. July, only hauls after that date are included.

|                   | Number<br>of hauls | Number of fish<br>caught per hour |
|-------------------|--------------------|-----------------------------------|
|                   |                    | 1956      1955                    |
| N. Kattegat ..... | 11                 | 9      347                        |
| S. Kattegat ..... | 5                  | 502      10                       |

It may be seen that in the northern Kattegat the number of cod was very low as compared with 1955, while in the southern Kattegat the reverse was the case, the number of cod in 1956 being far in excess of the numbers found in 1955. In most catches 1-group cod predominated and remarkably few 0-group fish were entering the stock. This agrees well with the fact that hauls made in April yielded practically no cod larvae.

**Belts.** The table gives the number of cod obtained per 1 hour's fishing with the cod trawl from S/S "Biologen". Only hauls made after 1. July are included.

|                      | Number<br>of hauls | Number of fish<br>caught per hour |
|----------------------|--------------------|-----------------------------------|
|                      |                    | 1956      1955                    |
| Belts, N. part ..... | 27                 | 64      833                       |
| Belts, S. part ..... | 34                 | 55      135                       |
| W. Baltic .....      | 12                 | 190      319                      |

It may be observed that in all areas the number of cod found in 1956 was inferior to that in 1955. This is due to the fact that the number of 0-group cod was much smaller in 1956 than in the previous year. In most years 0-group cod completely

dominate the catches in autumn but this was not the case in 1956. Hauls made with the stramin net earlier in the year also indicated that the 1956 year-class was a poor one. This is no doubt due to the low temperatures prevailing in the water during the winter 1955/56, to which the long period of ice cover is attributable. As in previous years, the porportion of older cod (III group and older) was small.

J. KNUDSEN

### Whiting

**Kattegat.** The number of whiting obtained per 1 hour's fishing with the cod trawl from S/S "Biologen" is recorded in the following table:—

|                           | June | September | November |
|---------------------------|------|-----------|----------|
| Number of hauls .....     | 15   | 1         | 13       |
| Number of fish } 1956 ..  | 87   | 172       | 523      |
| per 1-hour haul { 1955 .. | 37   | 1544      | 1383     |

It appears that in autumn the number of whiting present in the area was much below the number found the previous year. As usual the majority of the stock in autumn consists of 0-group fish and it would seem that the 1956 0-group is smaller than that of the previous year.

**Belts.** The number of whiting obtained with the cod trawl from S/S "Biologen" is recorded in the following table:—

|                        | June | Aug. | Sept. | Oct. | Nov.—<br>Dec. |
|------------------------|------|------|-------|------|---------------|
| Belts                  |      |      |       |      |               |
| Number of hauls ...    | 7    | 10   | 25    | 8    | 18            |
| Number of fish } 1956  | 23   | 16   | 155   | 189  | 592           |
| per 1-hour haul } 1955 | —    | 4    | 120   | 258  | 126           |
| W. Baltic              |      |      |       |      |               |
| Number of hauls ...    | —    | 3    | 4     | 3    | 2             |
| Number of fish } 1956  | —    | 2    | 24    | 211  | 8             |
| per 1-hour haul } 1955 | —    | 4    | —     | 3    | 392           |

It appears that, as was the case in 1955 also, only few whiting were present in the first half of the year. In September considerable quantities were obtained in the Belts and in October considerable quantities seemed to be present in the western Baltic also. This is due to the fact that in the latter part of the summer large numbers of 0-group fish migrate into the area. The number of hauls, however, was too small to allow any statement to be made as to whether the migration in 1956 was of the same magnitude as that of the previous year.

J. KNUDSEN

## COMMERCIAL FISH COD

### Greenland Stock

#### Cod Investigations in the Coastal Waters and on the Offshore Banks of West Greenland in 1956

(Figures 4-5; Tables 8-11)

##### 1. The age composition

###### a. Offshore banks

Age determinations were made on 1700 otoliths of cod from the banks, of which 551 (Nos. 3, 4, and 8 in Table 8) were collected by the "Dana" from catches made by jig and 1149 collected by the "Adolf Jensen" mainly from long-line catches.

The age analyses of fish caught on the offshore banks are given in Table 8, together with the average lengths of males and females. Figure 4 shows the age compositions of eight catches from the banks (left-hand column). The 1947 year-class predominated in all the samples, as in 1955. It amounted to between 40 and 60% of the catches. In sample No. 5, however, it made up only 32.3%.

Year-classes older than that of 1947, for instance, the formerly rich 1942 and 1945 year-classes, were

only very sparsely represented in the catches on the banks. In most of the samples the 1942 year-class was less than 5%, though in sample No. 7 it amounted to a little more than 20%. Among the year-classes younger than 1947 only the 1950 year-class was of some importance though it did not reach more than 30% in any of the samples.

The length distributions of cod in the various samples shown in Figure 4 (right-hand column) are very similar, most graphs having a maximum between 70 and 75 cm., corresponding to a mean weight of 3.5 to 4 kg.

###### b. Inshore waters and fjords

Table 9 gives the results of 4021 age determinations made with otoliths from samples from the inshore waters and the fjords. The samples come from sub-areas 1A to 1F (Figure 5). Unfortunately no samples were collected in the important sub-area 1C. Most of the samples were from catches made with cod hooks on long-lines. Nos. 12 and 16 came from pound-net catches, Nos. 14, 29, and



Table 8. Percentage age composition of the cod on West Greenland banks in 1956, together with the mean lengths of males and females at each age

| Year-class   | Age-group | 1                                                                  |      |      | 2                                                                  |      |       | 3                                                |       |      | 4                                               |      |      |
|--------------|-----------|--------------------------------------------------------------------|------|------|--------------------------------------------------------------------|------|-------|--------------------------------------------------|-------|------|-------------------------------------------------|------|------|
|              |           | Store Hellefiske Bank<br>66°51'N., 54°10'W.<br>Aug., 60 m., 3.6°C. |      |      | Lille Hellefiske Bank<br>65°10'N., 53°16'W.<br>Aug., 90 m., 1.1°C. |      |       | Banana Bank<br>64°10'N., 53°23'W.<br>July, 60 m. |       |      | Fylla Bank<br>64°08'N., 52°45'W.<br>July, 45 m. |      |      |
|              |           | Length, cm.                                                        |      |      | Length, cm.                                                        |      |       | Length, cm.                                      |       |      | Length, cm.                                     |      |      |
|              |           | %                                                                  | ♂♂   | ♀♀   | %                                                                  | ♂♂   | ♀♀    | %                                                | ♂♂    | ♀♀   | %                                               | ♂♂   | ♀♀   |
| 1952         | IV        | 1.4                                                                | 46.5 | 43.0 | —                                                                  | —    | —     | 0.3                                              | 46.0  | —    | —                                               | —    | —    |
| 1951         | V         | 5.4                                                                | 57.1 | 56.1 | 3.5                                                                | 54.2 | 55.5  | 1.0                                              | 56.5  | 57.0 | 6.3                                             | 53.0 | 55.0 |
| 1950         | VI        | 26.5                                                               | 62.9 | 64.6 | 11.0                                                               | 63.6 | 64.9  | 14.5                                             | 63.8  | 64.1 | 27.3                                            | 62.9 | 64.3 |
| 1949         | VII       | 5.0                                                                | 69.1 | 69.6 | 5.0                                                                | 71.0 | 67.0  | 4.4                                              | 67.5  | 71.3 | 7.7                                             | 69.3 | 69.0 |
| 1948         | VIII      | 7.9                                                                | 69.3 | 70.7 | 3.5                                                                | 71.8 | 69.0  | 7.4                                              | 69.8  | 71.5 | 8.4                                             | 68.4 | 70.0 |
| 1947         | IX        | 39.8                                                               | 72.4 | 74.7 | 52.0                                                               | 71.3 | 72.1  | 59.9                                             | 73.4  | 75.2 | 42.7                                            | 71.6 | 74.2 |
| 1946         | X         | 0.9                                                                | 75.0 | 76.0 | 2.0                                                                | 76.0 | 76.3  | 2.7                                              | 78.8  | 77.5 | 1.0                                             | 72.0 | —    |
| 1945         | XI        | 6.1                                                                | 77.4 | 79.6 | 12.0                                                               | 79.5 | 79.2  | 6.1                                              | 77.3  | 79.3 | 4.9                                             | 77.3 | 70.0 |
| 1944         | XII       | 1.6                                                                | 75.3 | 83.5 | 1.5                                                                | 75.0 | 74.0  | 0.3                                              | —     | 81.0 | —                                               | —    | —    |
| 1943         | XIII      | 1.1                                                                | 78.0 | 78.3 | 1.0                                                                | 84.0 | 77.0  | 0.7                                              | 84.0  | 80.0 | —                                               | —    | —    |
| 1942         | XIV       | 3.6                                                                | 80.7 | 82.6 | 4.5                                                                | 82.5 | 85.0  | 2.0                                              | 85.3  | 93.0 | 2.1                                             | 79.7 | —    |
| 1941         | XV        | —                                                                  | —    | —    | 1.5                                                                | 81.0 | 83.5  | —                                                | —     | —    | —                                               | —    | —    |
| 1940         | XVI       | —                                                                  | —    | —    | 1.5                                                                | 83.0 | 85.5  | 0.3                                              | 111.0 | —    | —                                               | —    | —    |
| 1939         | XVII      | 0.5                                                                | 83.0 | 82.0 | —                                                                  | —    | —     | —                                                | —     | —    | —                                               | —    | —    |
| 1938         | XVIII     | —                                                                  | —    | —    | —                                                                  | —    | —     | —                                                | —     | —    | —                                               | —    | —    |
| 1937         | XIX       | —                                                                  | —    | —    | —                                                                  | —    | —     | —                                                | —     | —    | —                                               | —    | —    |
| 1936         | XX        | —                                                                  | —    | —    | 0.5                                                                | —    | 90.0  | 0.3                                              | —     | 97.0 | —                                               | —    | —    |
| 1935         | XXI       | —                                                                  | —    | —    | —                                                                  | —    | —     | —                                                | —     | —    | —                                               | —    | —    |
| 1934         | XXII      | 0.2                                                                | 91.0 | —    | 0.5                                                                | —    | 103.0 | —                                                | —     | —    | —                                               | —    | —    |
| Total number |           | 442                                                                |      |      | 200                                                                |      |       | 297                                              |       |      | 143                                             |      |      |

| Year-class   | Age-group | 5                                               |      |      | 6                                                       |      |      | 7                                                        |      |      | 8                                                      |      |      |
|--------------|-----------|-------------------------------------------------|------|------|---------------------------------------------------------|------|------|----------------------------------------------------------|------|------|--------------------------------------------------------|------|------|
|              |           | Fylla Bank<br>64°03'N., 52°27'W.<br>May, 120 m. |      |      | Fylla Bank<br>64°02'N., 52°47'W.<br>Aug., 40 m., 3.7°C. |      |      | Fylla Bank<br>63°53'N., 53°22'W.<br>June, 260 m., 4.0°C. |      |      | Dana Bank<br>62°42'N., 51°20'W.<br>July, 50 m., 1.1°C. |      |      |
|              |           | Length, cm.                                     |      |      | Length, cm.                                             |      |      | Length, cm.                                              |      |      | Length, cm.                                            |      |      |
|              |           | %                                               | ♂♂   | ♀♀   | %                                                       | ♂♂   | ♀♀   | %                                                        | ♂♂   | ♀♀   | %                                                      | ♂♂   | ♀♀   |
| 1952         | IV        | 2.0                                             | 40.0 | 44.0 | 3.4                                                     | 47.2 | 44.0 | —                                                        | —    | —    | —                                                      | —    | —    |
| 1951         | V         | 4.9                                             | 54.0 | 54.3 | 7.2                                                     | 56.5 | 57.3 | 0.6                                                      | —    | 45.0 | —                                                      | —    | —    |
| 1950         | VI        | 29.4                                            | 60.8 | 63.1 | 20.3                                                    | 63.5 | 64.2 | 4.1                                                      | 60.5 | 60.0 | 10.8                                                   | 60.2 | 63.0 |
| 1949         | VII       | 2.0                                             | 77.0 | 72.0 | 9.3                                                     | 70.6 | 70.6 | 0.6                                                      | 71.0 | 71.0 | 12.6                                                   | 68.2 | 68.5 |
| 1948         | VIII      | 3.9                                             | 67.5 | 65.5 | 7.2                                                     | 69.9 | 73.1 | 2.4                                                      | 70.0 | 67.0 | 1.8                                                    | —    | 71.0 |
| 1947         | IX        | 32.3                                            | 69.7 | 74.4 | 43.2                                                    | 72.4 | 76.0 | 42.9                                                     | 72.0 | 71.3 | 45.4                                                   | 71.8 | 75.0 |
| 1946         | X         | 1.0                                             | —    | 81.0 | 1.3                                                     | 77.5 | 83.0 | 0.6                                                      | —    | 73.0 | 5.4                                                    | 69.8 | 67.5 |
| 1945         | XI        | 11.8                                            | 79.0 | 79.9 | 4.7                                                     | 77.4 | 77.0 | 11.2                                                     | 77.5 | 76.9 | 16.2                                                   | 77.1 | 76.5 |
| 1944         | XII       | 2.9                                             | 79.0 | 87.0 | 0.8                                                     | 96.0 | 69.0 | 1.8                                                      | 77.3 | 77.3 | 0.9                                                    | —    | 76.0 |
| 1943         | XIII      | 2.9                                             | —    | 75.7 | 0.8                                                     | —    | 87.5 | 6.5                                                      | 78.3 | 74.9 | —                                                      | —    | —    |
| 1942         | XIV       | 4.9                                             | 91.0 | 83.3 | 1.7                                                     | 83.0 | 84.5 | 22.4                                                     | 80.8 | 81.1 | 5.4                                                    | 77.0 | 89.0 |
| 1941         | XV        | 1.0                                             | —    | 86.0 | —                                                       | —    | —    | 1.2                                                      | —    | 77.0 | 0.9                                                    | 76.0 | —    |
| 1940         | XVI       | —                                               | —    | —    | —                                                       | —    | —    | 4.1                                                      | 85.8 | 86.9 | 0.9                                                    | 80.0 | —    |
| 1939         | XVII      | —                                               | —    | —    | —                                                       | —    | —    | 1.2                                                      | 84.0 | 84.0 | —                                                      | —    | —    |
| 1938         | XVIII     | —                                               | —    | —    | —                                                       | —    | —    | —                                                        | —    | —    | —                                                      | —    | —    |
| 1937         | XIX       | —                                               | —    | —    | —                                                       | —    | —    | —                                                        | —    | —    | —                                                      | —    | —    |
| 1936         | XX        | 1.0                                             | —    | 93.0 | —                                                       | —    | —    | —                                                        | —    | —    | —                                                      | —    | —    |
| 1935         | XXI       | —                                               | —    | —    | —                                                       | —    | —    | —                                                        | —    | —    | —                                                      | —    | —    |
| 1934         | XXII      | —                                               | —    | —    | —                                                       | —    | —    | —                                                        | —    | —    | —                                                      | —    | —    |
| Total number |           | 102                                             |      |      | 236                                                     |      |      | 169                                                      |      |      | 111                                                    |      |      |

30 from trawl catches, and Nos. 13 and 31 came from catches with the jig.

In the sample from sub-area 1 A (No. 9) the 1942 year-class (XIV) predominated at 42%. No samples were collected in the northern part of sub-area 1 B. From the southern part there are two samples (Nos. 10 and 11); these differ very

much in regard to age composition. No. 10 was taken from a Greenlandic catch with long-lines from rather shallow water while No. 11 was taken with long-lines by the "Adolf Jensen" in 100 to 200 m. depth south of Holsteinsborg. In sample No. 10 only the 1950 and 1947 year-classes were of importance, at 35 and 24% respectively. Sample

Table 9. Percentage age composition from West Greenland inshore waters and fjords in 1956

| Year-class     | Age-group | 9<br>Aug.<br>Sept.<br>Oct. | 10<br>Aug.<br>Sept. | 11<br>Sept. | 12<br>June | 13<br>Apr. | 14<br>Febr. | 15<br>Oct. | 16<br>June | 17<br>Dec. | 18<br>June | 19<br>Oct. |
|----------------|-----------|----------------------------|---------------------|-------------|------------|------------|-------------|------------|------------|------------|------------|------------|
| 1952 ... IV    |           | —                          | —                   | 2.0         | 16.8       | —          | 14.9        | 1.0        | 22.4       | 7.9        | 4.0        | 2.6        |
| 1951 ... V     |           | 0.7                        | —                   | 6.0         | 26.9       | 0.9        | 26.6        | 1.0        | 10.5       | 5.0        | 4.0        | 4.2        |
| 1950 ... VI    |           | 1.4                        | 0.5                 | 35.0        | 26.9       | 7.3        | 22.3        | 9.0        | 26.3       | 12.9       | 21.9       | 22.2       |
| 1949 ... VII   |           | —                          | —                   | 5.0         | 6.7        | 4.5        | 8.5         | 4.0        | 11.4       | 10.9       | 26.9       | 13.2       |
| 1948 ... VIII  |           | 0.7                        | 0.5                 | 3.0         | —          | 4.5        | 2.1         | 3.0        | 1.8        | 6.9        | 6.5        | 2.6        |
| 1947 ... IX    |           | 10.7                       | 12.3                | 24.0        | 9.2        | 20.0       | 8.5         | 26.0       | 14.0       | 12.9       | 25.9       | 27.0       |
| 1946 ... X     |           | —                          | 2.7                 | 2.0         | —          | 2.7        | 1.6         | —          | 0.9        | —          | 1.5        | 1.1        |
| 1945 ... XI    |           | 12.9                       | 5.9                 | 5.0         | 4.2        | 18.2       | 10.1        | 7.0        | 6.6        | 15.8       | 6.0        | 12.7       |
| 1944 ... XII   |           | 4.3                        | 5.5                 | 4.0         | —          | 2.7        | 1.1         | 2.0        | —          | 2.9        | —          | 1.6        |
| 1943 ... XIII  |           | 9.3                        | 5.5                 | 2.0         | —          | 1.8        | —           | —          | —          | 2.0        | 0.5        | 1.6        |
| 1942 ... XIV   |           | 42.1                       | 25.9                | 5.0         | 2.5        | 14.5       | 3.7         | 22.0       | 3.5        | 8.8        | 1.5        | 7.9        |
| 1941 ... XV    |           | 6.4                        | 5.5                 | —           | —          | —          | —           | —          | —          | —          | 0.5        | —          |
| 1940 ... XVI   |           | 4.3                        | 11.8                | 3.0         | 4.2        | 19.1       | 0.5         | 19.0       | 1.3        | 11.9       | 0.5        | 1.1        |
| 1939 ... XVII  |           | 1.4                        | 7.3                 | —           | —          | 1.8        | —           | 2.0        | 0.4        | 1.0        | —          | 0.5        |
| 1938 ... XVIII |           | —                          | 2.3                 | —           | 0.8        | 0.9        | —           | 1.0        | —          | —          | 0.5        | 0.5        |
| 1937 ... XIX   |           | —                          | 1.4                 | —           | —          | —          | —           | —          | —          | —          | —          | —          |
| 1936 ... XX    |           | 5.7                        | 11.8                | 2.0         | 1.7        | 0.9        | —           | 3.0        | —          | 1.0        | —          | 0.5        |
| 1935 ... XXI   |           | —                          | —                   | —           | —          | —          | —           | —          | —          | —          | —          | —          |
| 1934 ... XXII  |           | —                          | 1.4                 | 2.0         | —          | —          | —           | —          | 0.9        | —          | —          | 0.5        |
| Total number   |           | 141                        | 220                 | 100         | 119        | 110        | 188         | 100        | 228        | 101        | 201        | 189        |

| Year-class     | Age-group | 20<br>Feb. | 21<br>Sept. | 22<br>June | 23<br>Apr.,<br>May | 24<br>Sept. | 25<br>Sept. | 26<br>July | 27<br>Oct. | 28<br>May | 29<br>Jan. | 30<br>Oct. | 31<br>Aug. | 32<br>Oct. |
|----------------|-----------|------------|-------------|------------|--------------------|-------------|-------------|------------|------------|-----------|------------|------------|------------|------------|
| 1952 ... IV    |           | —          | 2.0         | 6.9        | 8.9                | —           | —           | 1.5        | 7.0        | 1.0       | 11.8       | 1.0        | 8.9        | —          |
| 1951 ... V     |           | 1.5        | 3.1         | 9.5        | 4.9                | 4.5         | —           | 4.0        | 10.6       | 7.5       | 7.6        | 4.0        | 14.9       | 1.8        |
| 1950 ... VI    |           | 10.3       | 12.8        | 33.6       | 53.7               | 44.0        | 4.7         | 37.5       | 36.2       | 23.1      | 28.6       | 8.1        | 50.1       | 14.7       |
| 1949 ... VII   |           | 2.9        | 10.7        | 9.5        | 9.9                | 17.5        | 5.3         | 28.5       | 12.6       | 29.6      | 22.7       | 15.1       | 14.9       | 11.2       |
| 1948 ... VIII  |           | 1.5        | 3.6         | 0.9        | 1.0                | 1.5         | 4.7         | 4.0        | 2.5        | 3.5       | 5.9        | 2.0        | 1.3        | 2.4        |
| 1947 ... IX    |           | 35.3       | 43.4        | 9.5        | 15.8               | 21.0        | 43.3        | 17.5       | 23.1       | 32.7      | 9.2        | 43.4       | 5.8        | 35.3       |
| 1946 ... X     |           | —          | 2.6         | —          | —                  | —           | 2.7         | —          | —          | —         | 1.7        | —          | 0.5        | 4.7        |
| 1945 ... XI    |           | 26.5       | 8.2         | 14.7       | 3.9                | 7.5         | 19.3        | 5.5        | 3.5        | 1.0       | 12.6       | 22.2       | 2.8        | 19.4       |
| 1944 ... XII   |           | 4.4        | 2.0         | 4.3        | —                  | 0.5         | 1.3         | 0.5        | —          | —         | —          | —          | —          | 1.8        |
| 1943 ... XIII  |           | —          | 1.5         | 3.4        | —                  | 1.0         | 3.3         | —          | 1.0        | —         | —          | 1.0        | —          | 1.8        |
| 1942 ... XIV   |           | 10.3       | 6.1         | 6.0        | 2.0                | 2.0         | 8.0         | —          | 2.0        | 1.0       | —          | 3.0        | 0.8        | 2.9        |
| 1941 ... XV    |           | —          | —           | 0.9        | —                  | —           | 2.0         | —          | —          | —         | —          | —          | —          | 1.8        |
| 1940 ... XVI   |           | 4.4        | 2.0         | 0.9        | —                  | 0.5         | 3.3         | —          | 1.5        | 0.5       | —          | —          | —          | 1.8        |
| 1939 ... XVII  |           | 1.5        | 1.0         | —          | —                  | —           | 1.3         | —          | —          | —         | —          | —          | —          | —          |
| 1938 ... XVIII |           | 1.5        | —           | —          | —                  | —           | —           | 0.5        | —          | —         | —          | —          | —          | 0.6        |
| 1937 ... XIX   |           | —          | —           | —          | —                  | —           | —           | —          | —          | —         | —          | —          | —          | —          |
| 1936 ... XX    |           | —          | 1.0         | —          | —                  | —           | —           | 0.5        | —          | —         | —          | —          | —          | —          |
| 1935 ... XXI   |           | —          | —           | —          | —                  | —           | —           | —          | —          | —         | —          | —          | —          | —          |
| 1934 ... XXII  |           | —          | —           | —          | —                  | —           | 0.7         | —          | —          | —         | —          | —          | —          | —          |
| Total number   |           | 68         | 196         | 116        | 213                | 200         | 150         | 200        | 199        | 199       | 119        | 99         | 395        | 170        |

No. 11 contained mostly older year-classes with the 1942 year-class predominating at 25.9% and those of 1936, 1940, and 1947 amounting to 12% each.

The six samples Nos. 12, 13, 14, 15, 16, and 17 from sub-area 1 D were collected in Godthåb Fjord from catches made with different gear as mentioned above. There are very distinct differences in the year-class composition of catches taken with

different gear. The small, young cod were taken by pound-nets (Nos. 12 and 16) in which the year-classes of 1950 and earlier amounted to between 50 and 70% of the catches. Sample No. 13, from a catch taken by jig from the ice on the cod spawning ground at Kapisigdlit, contained mostly spawning cod of the older year-classes—1940, 1942, 1945, and 1947 which amounted to about 72% of the sample. These cod belonged to the

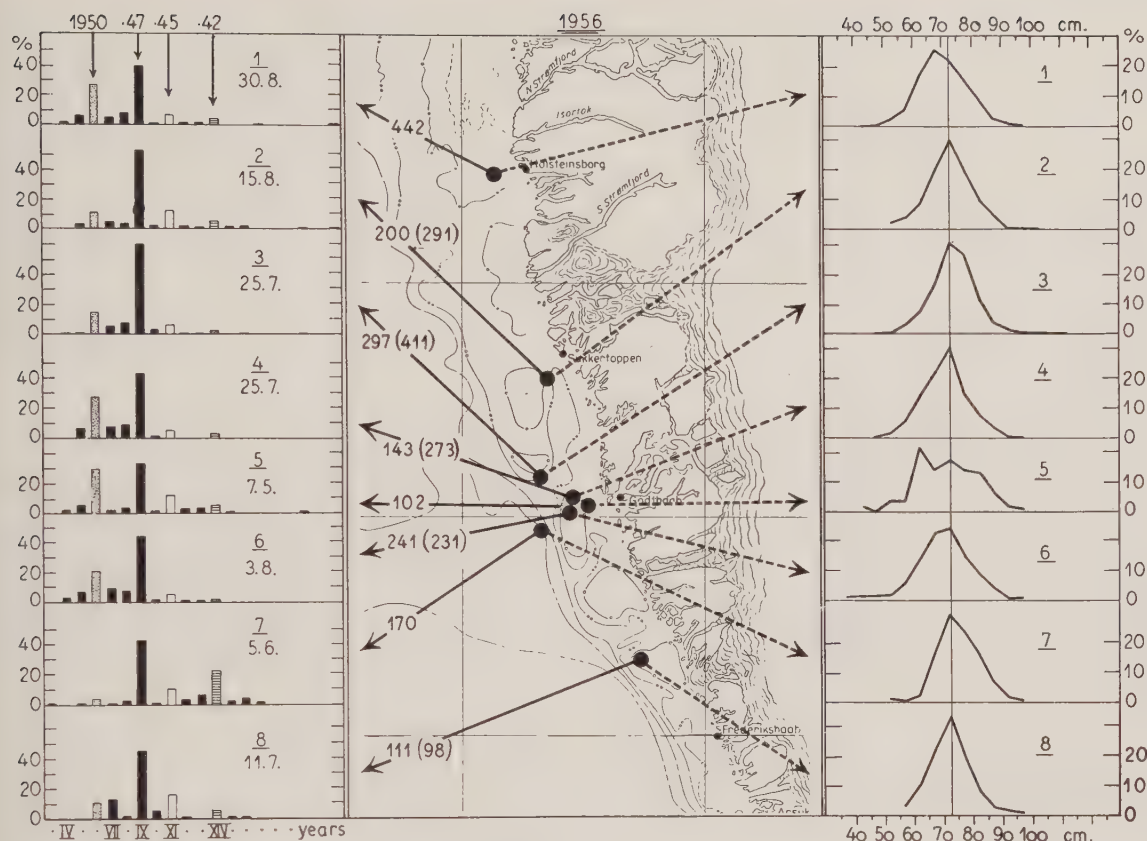


Figure 4. Percentage age distribution (left) and length measurements for 5 cm. groups (right) of cod caught on the Greenland banks in 1956. The numbers of fish examined and of cod tagged (bracketed figures) are given for each station.

fjord type, with a very slow growth-rate. The same fjord type was also found in sample No. 17, in which the year-classes older than 1945 were fairly well represented (43.5%).

Sample No. 15 of which the 1940, 1942, and 1947 year-classes together amounted to about 66%, was from a catch taken by long-line in 60 to 260 m. depth near the entrance to the fjord. The cod in this sample were of quite a different type from the cod in samples 13 and 17, so far as growth-rate is concerned. In this respect they were more like the old cod found on the offshore banks, and it is therefore possible that the cod found in the outer part of Godthåb Fjord originate from Fylla Bank.

Samples Nos. 18 and 19 from sub-area 1 E were from Greenlanders' catches, probably made with long-lines. Sample No. 18 contained merely young cod with the 1949 year-class predominating (27%). This year-class has only been of importance in

samples from sub-areas 1 E and 1 F. In sample No. 19 the 1947 year-class was predominant and the older year-classes of 1945 and 1942 were better represented than in sample No. 18.

Not less than 13 samples, containing in all 2324 specimens, were collected in sub-area 1 F. The 1950 year-class predominated in 7 samples while the 1947 year-class predominated in 6 samples. The 1945 year-class was less well represented than in previous years. As in sub-area 1 E, the 1949 year-class seems to have been fairly prominent in some of the catches.

The growing importance of the 1947 year-class in the catches in sub-area 1 in 1956 suggests the occurrence of an immigration by the 1947 year-class from the northern sub-area. There is reason to fear that this very important year-class will gradually emigrate in the coming years to other areas, as for example East Greenland and Iceland, as was the case with the 1945 year-class.

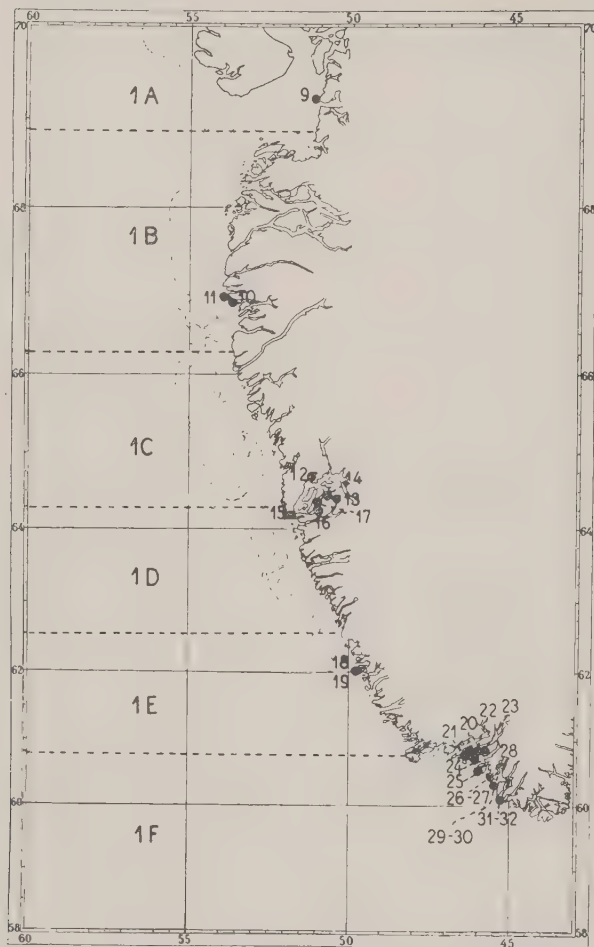


Figure 5. Localities at which otolith samples were collected for age analyses. The numbers correspond with those given in Table 9.

## 2. Tagging experiments

In 1956, 3273 cod were tagged in West Greenland waters; 623 recaptures were reported. The recoveries of the marked fish of different ages are given in Table 10. There were 597 recaptures in West Greenland waters, 21 in Icelandic waters, 3 on the Anton Dohrn Bank between East Greenland and Iceland, 1 at Bjørneø, and one from the Newfoundland Banks. The recapture at Bjørneø is rather doubtful, owing to the fact that the tag was found on a cod after it had been landed at Cuxhaven. The recapture in the Newfoundland area was made on Woolfall Bank, 47°07'N., 51°35'W., by a French trawler on 2. May 1956. The fish was tagged on 1. September 1955 south of Holsteinborg, 66°26'N., 53°53'W.

Three recoveries on the Anton Dohrn Bank were reported by German vessels. The recovery on 7. February 1956 has already been mentioned in Ann. Biol., XII (1955), p. 135. The two others were made in May 1956. One was tagged in September 1953 at position 60°23'N., 45°38'W. The other was tagged in September 1955 at position 64°04'N., 51°55'W. The former belonged to the 1949 year-class, the latter to the 1945.

Otoliths were collected for age determination from 368 recaptured cod. As in 1954 and 1955, the great majority of the cod recaptured in Icelandic and other distant waters belonged to the 1945 year-class. The 1947 year-class is represented by 4 recaptures off Iceland.

The age composition of cod recaptured in Greenland waters shows the predominance of the 1947 year-class. The two next most numerous year-classes were those of 1950 and 1945.

Table 10. Marked cod recaptured at Greenland (Gr.) and Iceland (Ic.) in 1956, tabulated according to age and year of liberation

| Year-class   | Age-group | Assumed according to age and year of liberation |                 |                 |                 |                 |                     |                         |                        |                 |     | Total |                    |  |
|--------------|-----------|-------------------------------------------------|-----------------|-----------------|-----------------|-----------------|---------------------|-------------------------|------------------------|-----------------|-----|-------|--------------------|--|
|              |           | 1948<br>Gr. Ic.                                 | 1949<br>Gr. Ic. | 1950<br>Gr. Ic. | 1951<br>Gr. Ic. | 1952<br>Gr. Ic. | 1953<br>Gr. Ic.     | 1954<br>Gr. Ic.         | 1955<br>Gr. Ic.        | 1956<br>Gr. Ic. | Gr. | %     | Ic.                |  |
| 1936         | XX        | —                                               | —               | —               | —               | I —             | —                   | 2 —                     | —                      | —               | 3   | 0.9   | —                  |  |
| 1937         | XIX       | —                                               | —               | —               | —               | I —             | —                   | —                       | I —                    | —               | 2   | 0.6   | —                  |  |
| 1938         | XVIII     | I —                                             | —               | —               | —               | —               | —                   | —                       | I —                    | —               | 2   | 0.6   | —                  |  |
| 1939         | XVII      | —                                               | —               | —               | —               | —               | —                   | —                       | I —                    | —               | I   | 0.3   | —                  |  |
| 1940         | XVI       | 2 —                                             | —               | —               | I —             | —               | —                   | 13 —                    | 7 —                    | —               | 23  | 6.7   | —                  |  |
| 1941         | XV        | —                                               | —               | —               | —               | —               | —                   | —                       | I —                    | —               | I   | 0.3   | —                  |  |
| 1942         | XIV       | I —                                             | —               | —               | —               | —               | I —                 | 9 I                     | 6 —                    | 2 —             | 19  | 5.5   | I                  |  |
| 1943         | XIII      | —                                               | —               | —               | —               | —               | I —                 | 3 —                     | 3 —                    | I —             | 8   | 2.3   | —                  |  |
| 1944         | XII       | —                                               | —               | —               | —               | I —             | I —                 | — I                     | 3 —                    | —               | 5   | 1.5   | I                  |  |
| 1945         | XI        | —                                               | I —             | —               | 2 2             | 3 2             | 4 (2) <sup>1</sup>  | 16 3                    | 16 —                   | 3 —             | 44  | 12.8  | ro <sup>1</sup>    |  |
| 1946         | X         | —                                               | —               | —               | —               | —               | —                   | 5 I                     | 3 —                    | —               | 8   | 2.3   | I                  |  |
| 1947         | IX        | —                                               | —               | —               | —               | 14 I            | 15 —                | 45 3                    | 43 —                   | 16 —            | 133 | 38.6  | 4                  |  |
| 1948         | VIII      | —                                               | —               | —               | I —             | —               | 2 —                 | 6 —                     | 9 —                    | 3 —             | 21  | 6.1   | —                  |  |
| 1949         | VII       | —                                               | —               | —               | I —             | —               | 2 —                 | 7 —                     | 12 (I) <sup>3</sup>    | 3 —             | 25  | 7.3   | I <sup>3</sup>     |  |
| 1950         | VI        | —                                               | —               | —               | —               | —               | 2 —                 | 6 —                     | 32 —                   | 6 —             | 46  | 13.4  | —                  |  |
| 1951         | V         | —                                               | —               | —               | —               | —               | —                   | —                       | 3 —                    | —               | 3   | 0.9   | —                  |  |
| ??.....?     |           | —                                               | —               | I —             | 7 I             | 11 I            | 18 —                | 62 4 (I) <sup>2</sup>   | 106 (I) <sup>4</sup>   | 48 —            | 253 | —     | 82 <sup>4</sup>    |  |
| Total number |           | 4 —                                             | I —             | I —             | 12 3            | 31 4            | 46 (2) <sup>1</sup> | 174 13 (I) <sup>2</sup> | 247 (2) <sup>3 4</sup> | 82 —            | 597 | —     | 26123 <sup>4</sup> |  |

Bank. <sup>4</sup>) One cod recaptured at Newfoundland.



Table 11. Cod recaptured in 1956

|                     | Greenland | Iceland | Other<br>areas |
|---------------------|-----------|---------|----------------|
| Denmark .....       | 1         | —       | —              |
| Greenland .....     | 140       | —       | —              |
| Faroe Islands ..... | 7         | —       | —              |
| Norway .....        | 21        | —       | —              |
| Iceland .....       | 7         | 18      | —              |
| United Kingdom....  | —         | 1       | —              |
| France .....        | 1         | —       | 1              |
| Germany .....       | 22        | 2       | 4              |
| Portugal .....      | 373       | —       | —              |
| Spain .....         | 22        | —       | —              |
| Italy .....         | 3         | —       | —              |
| Total .....         | 597       | 21      | 5              |

Table 11 gives the numbers of recaptures reported by different countries. As in the last three years, most of the recaptures were reported by Portuguese and Greenland fishermen.

The comparatively low number reported by Greenlanders in 1956, compared with 1955, may probably be due to the fact that more cod were tagged in 1956 on the offshore banks where no fishery is carried on by the Greenlanders.

PAUL M. HANSEN

### German Investigations

(Figure 6; Table 12)

German fishing activity in the waters of West, South, and East Greenland continued to increase. The total catch rose from 66,744 tons in 1955 to 76,681 tons in 1956 (West Greenland, 30,780 tons; South Greenland, 1,216 tons; East Greenland, 44,683 tons). The proportion of cod increased from 13.5% (9,041 tons) to 41.3% (31,672 tons) and that of redfish dropped from 83.0% to 51.8%.

#### West Greenland

In contrast to 1955, the West Greenland fishery in 1956 was a real cod season, for the trawlers did not succeed in finding the redfish concentrations as in the preceding year. Thus the yield of cod increased from 6,040 to 23,699 tons. The season started early, at the end of April, and lasted till the end of July. The daily catch was again best in June with 32.5 tons (gutted, landed weight). Most trawlers fished for fresh fish, but 4 trawlers landed from 8 trips 1,890 tons of green-salted cod.

As in the preceding year, the success of the West Greenland cod fishery was due to the strong 1947 year-class, which accounted for 40.6%. The average length of these fish was 71.6 cm. The 1945 and 1942 year-classes, important until 1955, have now become weak. The second best year-class was,

as expected, that of 1950, at 22.6%, and a mean over-all length of 61.7 cm. The average length of all West Greenland cod was, at 69.1 cm., nearly the same as in 1955 (68.7 cm.).

#### South Greenland

German trawlers developed little fishing activity in South Greenland waters. Large shoals of cod were found, but the fish were very small and a lot had to be rejected. The average length of the trawler landings was 64.2 cm. Most of the cod landed (53.1%) belonged to the 1950 year-class. The 1945 year-class, which was fairly abundant until 1955 in the trawler catches (28.5%) as well as in the "Anton Dohrn's" catches (15.6%), has now become weak. Age analysis again revealed the fact that the proportion of the 1949 year-class is larger in the south than in the west of Greenland. On the other hand, the strong 1947 year-class of West Greenland had only small commercial value in the south of Greenland and from 1955 to 1956 its proportions decreased to 9.1% (1955: 17.3% in the trawler catches, and 13.1% in those of the "Anton Dohrn").

#### East Greenland

Since the discovery by the German research vessel of large fish shoals on the Dohrn Bank in September 1955, the German trawlers have fished off East Greenland throughout the year, usually with success. In 1956, the fishery was favoured by exceptionally good ice conditions, for in winter and spring 1956 the East Greenland ice belt was very narrow. Most of the fishing took place on the Dohrn Bank (65°40'N., 30°W.) and off Angmagssalik (64°40'N., 35°W.), but some vessels also worked the Heimland Ridge and its south-western edge, and (after the Icelandic research trip by "Fylkir" in July) the grounds in south-east Greenland, near Cape Bille.

In 1955, the fishery off East Greenland rested mainly on redfish—the proportion of cod amounted only to 6.5%—but when the redfish catches fell off and the trawlers moved in again towards the banks, the output of cod increased. In 1956, 7,437 tons of cod were caught, i.e., 16.6% of the total catch. In December 1956 and January 1957, the cod catches on Dohrn Bank reached maxima of 39% and 46% respectively, an average daily output of 6.7 and 7.7 tons. In March and April 1957, the cod catches on Dohrn Bank far exceeded those of redfish and the daily catch of cod increased to 30–60 tons. In the Angmagssalik area and on Heimland Ridge in spring 1957 the yield of cod amounted to 25–30% of the total catch.

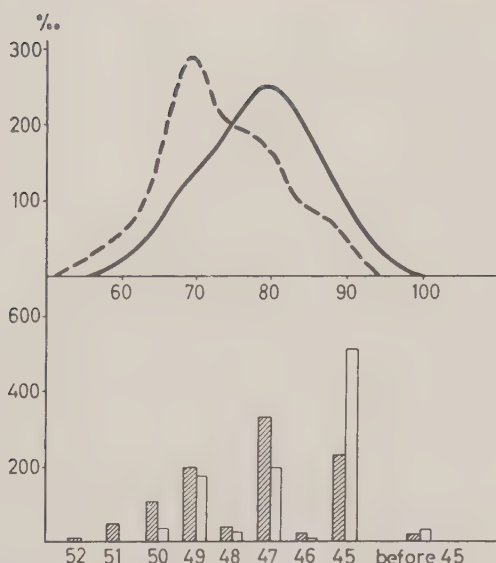


Figure 6. Length and age composition of Angmagssalik cod, caught in March and in the first week of April 1956 (continuous line) and at the end of April 1956 (stipled line).

As in 1955, the three year-classes 1945, 1947, and 1949 constituted the major part of the East Greenland stock of cod. There is apparently no doubt that the 1945 and 1949 year-classes are of Icelandic origin and a lot of them probably grew up in South Greenland waters. As regards the 1947 year-class, we presume that these cod belong to the West Greenland stock. This assumption is supported by tagging experiments and may also account for the retarded growth of this year-class. In March and April 1956 the average length of the 1947 year-class in the Angmagssalik area was 74.8 cm., whereas cod 2 years younger (born in 1949) measured 75.0 cm. The mean length of the 1945 year-class was 80.3 cm.

There is a difference in age composition between the cod on Dohrn Bank and at Angmagssalik. The proportion of the 1947 year-class is far greater on the western fishing ground and the age composition of Dohrn Bank cod lies somewhere between those of fish from Angmagssalik and N.W. Iceland. This difference in age composition between Angmagssalik and Dohrn Bank cod was again studied in spring 1957 and seems to be typical for that area.

The real spawning place of the East Greenland cod is still unknown, but we were able to draw certain conclusions about it from our examination of ungutted cod. In March and the first week of April 1956 most of the cod from Angmagssalik were found to be completely ripe. At the end of April we noticed a sudden increase in the proportion of

Table 12. Length and age composition of cod in West, South, and East Greenland in 1956 (<sup>0</sup>/<sub>100</sub>)

|             | West<br>Greenland<br>Fiskenaes/<br>Fylla | South<br>Greenland<br>C. Farvel/<br>Thorvaldsen | East Greenland<br>Ang-<br>magssalik | Dohrn<br>Bank |
|-------------|------------------------------------------|-------------------------------------------------|-------------------------------------|---------------|
| Length, cm. | May-July                                 | Aug.-Nov.                                       | Mar.-Apr.                           | May-Sept.     |
| 40—44       | —                                        | —                                               | —                                   | —             |
| 45—49       | 5                                        | 35                                              | —                                   | 1             |
| 50—54       | 16                                       | 126                                             | 2                                   | 13            |
| 55—59       | 70                                       | 269                                             | 12                                  | 42            |
| 60—64       | 187                                      | 239                                             | 51                                  | 89            |
| 65—69       | 280                                      | 185                                             | 129                                 | 101           |
| 70—74       | 251                                      | 82                                              | 177                                 | 145           |
| 75—79       | 132                                      | 35                                              | 228                                 | 150           |
| 80—84       | 39                                       | 15                                              | 207                                 | 187           |
| 85—89       | 15                                       | 7                                               | 131                                 | 130           |
| 90—94       | 4                                        | 3                                               | 45                                  | 82            |
| 95—99       | 1                                        | 2                                               | 11                                  | 36            |
| 100—104     | 0                                        | 1                                               | 4                                   | 11            |
| 105—109     | —                                        | 0                                               | 1                                   | 5             |
| >109        | —                                        | 1                                               | 2                                   | 2             |
| Year-class  |                                          |                                                 |                                     |               |
| 1953        | —                                        | 1                                               | —                                   | —             |
| 1952        | 1                                        | 13                                              | 1                                   | 10            |
| 1951        | 11                                       | 109                                             | 7                                   | 79            |
| 1950        | 226                                      | 531                                             | 46                                  | 162           |
| 1949        | 126                                      | 184                                             | 174                                 | 268           |
| 1948        | 103                                      | 16                                              | 32                                  | 31            |
| 1947        | 406                                      | 91                                              | 218                                 | 125           |
| 1946        | 20                                       | 3                                               | 15                                  | 6             |
| 1945        | 52                                       | 36                                              | 462                                 | 282           |
| before 1945 | 55                                       | 16                                              | 45                                  | 36            |

immature cod and consequently a remarkable decrease in length from 78.5 to 73.5 cm. (see Figure 6). That meant that the mass of mature cod, ready for spawning, had left Angmagssalik by the middle of April. But in the last week of April one third of the Angmagssalik cod still had ripe sexual organs, some just at the stage before spawning. At this time fishing off Angmagssalik ceased and started afresh on Dohrn Bank, where the output of cod in May reached its first maximum, at 25.9% of the total catch. Unfortunately, we obtained no ungutted cod from the Dohrn Bank in 1956, but were able to examine some in April 1957 and found most of the cod to be fully ripe and some were spawning or about to begin spawning. Moreover, at the end of April 1957, we obtained proof that cod were spawning in the Angmagssalik area also; we observed all stages of spawning from the beginning until the end of the spawning period.

From these preliminary studies of East Greenland cod we may conclude that the spawning migration of mature cod occurs very late in April and May and that the spawning area of the East Greenland cod extends from Angmagssalik (possibly west of Angmagssalik) to West Iceland. This means

that the fry spawned in East Greenland waters, or on the way from East Greenland to Iceland, are regularly carried by the Irminger Current to East, South-east, and South Greenland, and has developed (or is still developing) a self-contained stock of East Greenland cod. Besides the fry from genuine East Greenland cod, fry from Icelandic spawning grounds is also carried to Greenland, if the current conditions are favourable.

It is a very interesting fact that many of the very largest cod from East Greenland are still immature. These large juvenile cod belong mostly to the 1945 year-class. At the end of April 1956, about 75% of all cod born in 1945 which were caught off Angmagssalik were immature. Also in March 1957 about 25% of these 12-year-old cod were still juvenile. These findings agree well with the investigations made on the Icelandic spawning cod and prove that the unusually large bulk of first-time spawners of the 1945 year-class caught on the Icelandic spawning grounds in 1954, 1955, and 1956 immigrated mostly from East Greenland. They show further that the East Greenland waters are not only the connecting link between Greenland and Iceland, but also act as a reservoir for the large cod on which depends the fishery off East Greenland and Iceland, and which provide the Icelandic spawning stock.

The late onset of maturity of the cod in East Greenland waters may be due to the fact that these cod grow up in the colder waters off East

and South Greenland and that the ripening of the sexual organs is delayed by the colder waters of East Greenland through which they pass on their journey to the spawning grounds.

Examination of cod stomachs again revealed that East Greenland, especially Dohrn Bank, is an area of abundant food. Above all, immense shoals of bathypelagic fish and crustacea attract the cod. Further investigations will prove whether these areas are feeding grounds, to which come the mature cod after spawning in Icelandic waters.

ARNO MEYER

### Iceland Stock

#### On the Stock of Spawning Cod in 1956

(Tables 13 and 14)

In 1956 the 1945 year-class still dominated the commercial catches, as appears in Table 13, in which the numbers of fish are given in 10,000, for comparison with earlier years. The 1945 year-class dominated the age distribution of first-time spawners, making up about 50% of the total, as compared with an average of 28%. As mentioned in the 1955 report, this year-class became mature much later than usual, as 11-year-old fish; 53% of the class consisted of first-time spawners, against the normal of 19% for this age-group.

The Danish tagging experiments in West Greenland waters have shown that several fish

Table 13. The composition of the spawning stock of cod in 1956

| Age-group        | Age at first spawning |       |     |       |     |       |       |       |    |    |    |        | Total |    |        |
|------------------|-----------------------|-------|-----|-------|-----|-------|-------|-------|----|----|----|--------|-------|----|--------|
|                  | 4                     | 5     | 6   | 7     | 8   | 9     | 10    | 11    | 12 | 13 | 14 |        |       |    |        |
| IV .....         | 35                    | —     | —   | —     | —   | —     | —     | —     | —  | —  | —  | 35     |       |    |        |
| V .....          | 5                     | 120   | —   | —     | —   | —     | —     | —     | —  | —  | —  | 125    |       |    |        |
| VI .....         | 5                     | 15    | 416 | —     | —   | —     | —     | —     | —  | —  | —  | 436    |       |    |        |
| VII .....        | —                     | 35    | 150 | 1,318 | —   | —     | —     | —     | —  | —  | —  | 1,503  |       |    |        |
| VIII .....       | —                     | —     | 20  | 125   | 441 | —     | —     | —     | —  | —  | —  | 586    |       |    |        |
| IX .....         | —                     | —     | 5   | 45    | 140 | 451   | —     | —     | —  | —  | —  | 641    |       |    |        |
| X .....          | —                     | —     | —   | 10    | 40  | 105   | 271   | —     | —  | —  | —  | 426    |       |    |        |
| XI .....         | —                     | —     | —   | 25    | 276 | 772   | 1,644 | 3,053 | —  | —  | —  | 5,770  |       |    |        |
| XII .....        | —                     | —     | 5   | 5     | 10  | 20    | 70    | 80    | 45 | —  | —  | 235    |       |    |        |
| XIII .....       | —                     | —     | —   | 5     | 15  | 15    | 30    | 30    | 20 | 15 | —  | 130    |       |    |        |
| XIV .....        | —                     | —     | —   | 10    | 15  | 15    | 10    | 10    | 20 | —  | 5  | 85     |       |    |        |
| XV .....         | —                     | —     | —   | —     | —   | 5     | —     | —     | —  | —  | —  | 5      |       |    |        |
| XVI .....        | —                     | —     | —   | —     | —   | 5     | —     | 5     | —  | —  | —  | 10     |       |    |        |
| XVII .....       | —                     | —     | —   | —     | —   | —     | —     | —     | —  | —  | —  | —      |       |    |        |
| XVIII .....      | —                     | —     | —   | —     | —   | —     | —     | —     | —  | —  | —  | —      |       |    |        |
| XIX .....        | —                     | —     | —   | —     | 5   | —     | —     | —     | —  | —  | —  | 5      |       |    |        |
| XX .....         | —                     | —     | —   | —     | 5   | 5     | —     | —     | —  | —  | —  | 10     |       |    |        |
| Total .....      | 45                    | 170   | 596 | 1,543 | 947 | 1,393 | 2,025 | 3,178 | 85 | 15 | 5  | 10,002 |       |    |        |
| Spawning classes |                       |       |     |       |     |       |       |       |    |    |    |        |       |    |        |
| 1                | 2                     | 3     | 4   | 5     | 6   | 7     | 8     | 9     | 10 | 11 | 12 | 13     | 14    | 15 | Total  |
| 6,170            | 2,284                 | 1,037 | 351 | 60    | 40  | 30    | 15    | —     | —  | —  | 10 | 5      | —     | —  | 10,002 |



Table 14. Comparison between the growth of the cod in Iceland and Greenland

|                                 | Age-groups                  | VII  | VIII | IX   | X    | XI   |
|---------------------------------|-----------------------------|------|------|------|------|------|
| Iceland                         | { Average for 1928—51 ..... | 79.2 | 81.8 | 85.6 | 87.3 | 90.6 |
|                                 | { Average for 1955 .....    | 84.8 | 87.2 | 90.0 | 86.4 | 93.8 |
| Iceland 1945 year-class .....   |                             | 76.9 | 80.2 | 81.7 | 86.4 | 85.4 |
| Greenland 1945 year-class ..... |                             | 71.5 | 74.5 | —    | 77.0 | 77.0 |

belonging to this year-class were recaptured on the Icelandic spawning grounds. The mixing of the slow-growing Greenland cod with the faster-growing Icelandic stock is also clearly to be seen in Table 14. The growth of the 1945 year-class in Icelandic waters was fairly normal until its seventh year, but from then onwards, its growth was far below average. The estimated growth of the 1945 year-class in Greenland is based on samples from our trawl hauls there. The differences in length between areas as regards age-groups VII and VIII are in fact greater, as the Greenland values are taken from autumn observations, but the Icelandic are from observations in spring. When these two stocks mix together on the spawning grounds, it is not easy to distinguish between them by their otoliths, but the decrease in the average lengths surely indicates a certain degree of mixture.

JÓN JÓNSSON

shoals. Its proportion rose from 3.4 to 24.7%. Accordingly the average length of the fish, most of which were first-time spawners, was 78.2 cm. The 1950 year-class was also very abundant and predominated in the catches taken off N.W. and S.E. Iceland, amounting to 28.4% and 45.7% respectively. The mean length of these immature 6-year-old cod was 69.3 cm. The 1951 year-class entered the fishery for the first time.

ARNO MEYER

### German Investigations

(Table 15)

In summer 1956, the cod fishery in Icelandic waters was particularly handicapped by heavy ice to the north and north-west of Iceland. Accordingly, the decrease in the output of cod from 38,900 tons in 1955 (25.8% of total) to 24,251 tons in 1956 (19.6% of total) was not a sign of a poor stock of cod, but was caused by the anomalous hydrographic conditions in the "Gammelloch", the most important ground for the German cod fishery around Iceland. In the south-west, south, and south-east of Iceland the proportion of cod in the German catches showed a further increase, both in general and in the average daily output (especially in the south-east).

The rich 1945 year-class continued to be of great commercial value, although it dropped from 75% to 47.5% of the yield in the south-western spawning grounds and from 36.0% to 22.7% on the north-western feeding grounds. The average length of this 11-year-old cod is now 86.7 cm. The next most important year-class, viz., 1949, migrated in 1956 for the first time to the spawning grounds in large

Table 15. Length and age composition of cod taken by German vessels S.W., N.W., and S.E. of Iceland in 1956 (<sup>0</sup>/<sub>100</sub>)

| Length, cm.       | S.W. | N.W. | S.E. |
|-------------------|------|------|------|
| 35—39 .....       | —    | 1    | —    |
| 40—44 .....       | —    | 1    | —    |
| 45—49 .....       | 0    | 11   | 2    |
| 50—54 .....       | 1    | 40   | 12   |
| 55—59 .....       | 4    | 67   | 39   |
| 60—64 .....       | 18   | 113  | 84   |
| 65—69 .....       | 61   | 175  | 168  |
| 70—74 .....       | 134  | 155  | 212  |
| 75—79 .....       | 179  | 126  | 161  |
| 80—84 .....       | 206  | 118  | 111  |
| 85—89 .....       | 195  | 98   | 86   |
| 90—94 .....       | 124  | 48   | 59   |
| 95—99 .....       | 51   | 34   | 33   |
| 100—104 .....     | 16   | 6    | 19   |
| 105—109 .....     | 9    | 4    | 6    |
| 110—114 .....     | 2    | 3    | 4    |
| >114 .....        | 0    | 1    | 4    |
| Year-class        |      |      |      |
| 1953 .....        | —    | 8    | —    |
| 1952 .....        | 1    | 68   | 7    |
| 1951 .....        | 5    | 115  | 127  |
| 1950 .....        | 70   | 284  | 457  |
| 1949 .....        | 247  | 217  | 306  |
| 1948 .....        | 57   | 32   | 21   |
| 1947 .....        | 75   | 21   | 1    |
| 1946 .....        | 14   | 7    | 2    |
| 1945 .....        | 475  | 227  | 70   |
| before 1945 ..... | 56   | 21   | 9    |



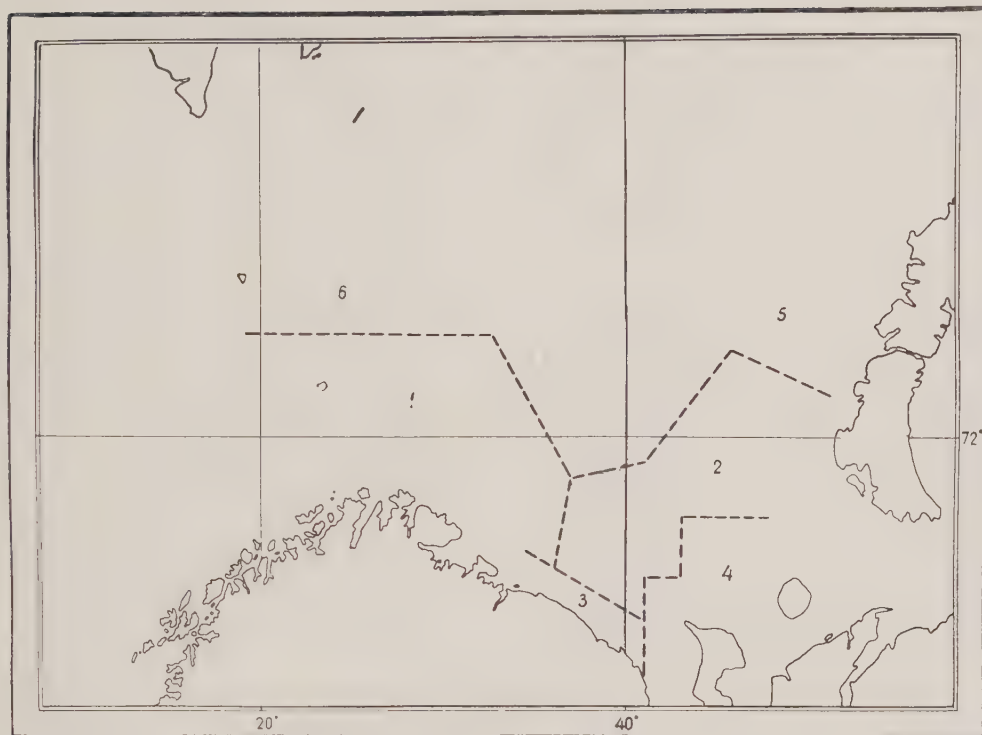


Figure 7. Location of fishing grounds.

- |                          |                           |
|--------------------------|---------------------------|
| 1. Western grounds.      | 4. South-eastern grounds. |
| 2. Central grounds.      | 5. North-eastern grounds. |
| 3. Murman coast grounds. | 6. North-western grounds. |

## Arcto-Norwegian Stock

### Soviet Investigations into the Biology of Gadoid Fish in the Barents Sea

(Figures 7-13; Table 16)

#### Cod and haddock

The stocks of cod and haddock were investigated by the Polar Institute in two ways. In the first place, mass measurements were made on the catches of reconnaissance trawlers and research ships which fished in various parts of the sea throughout the year. Samples of otoliths were collected to determine age.

The number of fish of which the ages were determined from otoliths for the years 1951-1955 was comparatively small. Thus, in the southern part of the sea, the number of age determinations on cod varied from 4100 to 5300; in the north-western region (Bear Island, Spitsbergen, Hope Island), it was 1500 to 2700. The number of age determinations on haddock in the southern part of the Barents Sea during this period varied from 1250 to 2700. For north-western regions, at Bear

Island and in the Through south of South Cape, the observations on haddock were irregular and the data for this region have been disregarded. In spite of the fact that the number of samples was small, the results may be considered satisfactory in so far as the rich year-classes were clearly defined, although their absolute strength for any one year could not be precisely determined. Accordingly, for both cod and haddock, a method of combining mass measurement data with otolith age determinations was used.

As a rule the number of fish measured was much greater than the number for which age was determined from otoliths. The number of cod measured in the period 1951-1955 in the southern part of the sea varied from 125,000 to 370,000, in north-western regions, from 67,000 to 118,000; and the number of haddock measured in the southern part of the sea was between 73,000 and 140,000. To obtain a more representative picture of the age composition, each size category was divided into separate year-classes according to the size distribution in age samples, and the combined data for each year are given in Figure 8. Figure 9 gives the

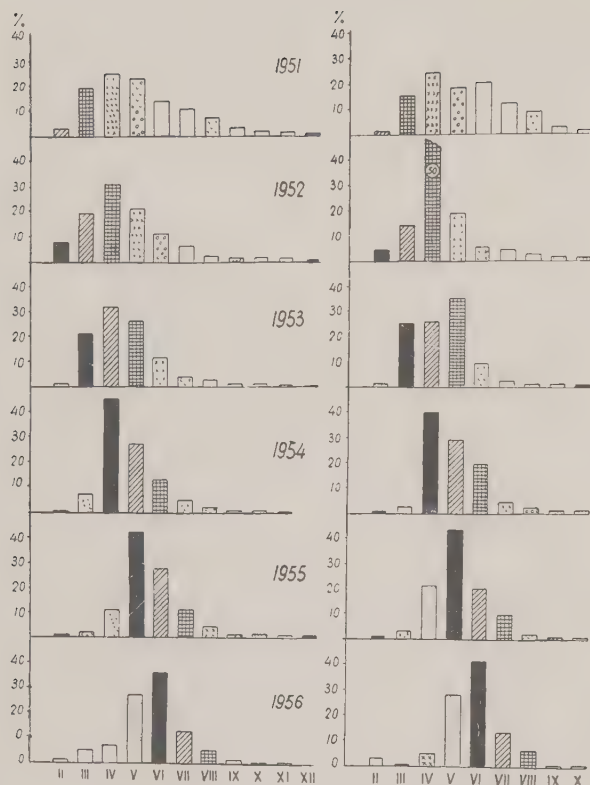


Figure 8. Age composition of cod.  
Left-hand side: southern part of the Barents Sea.  
Right-hand side: north-western regions.

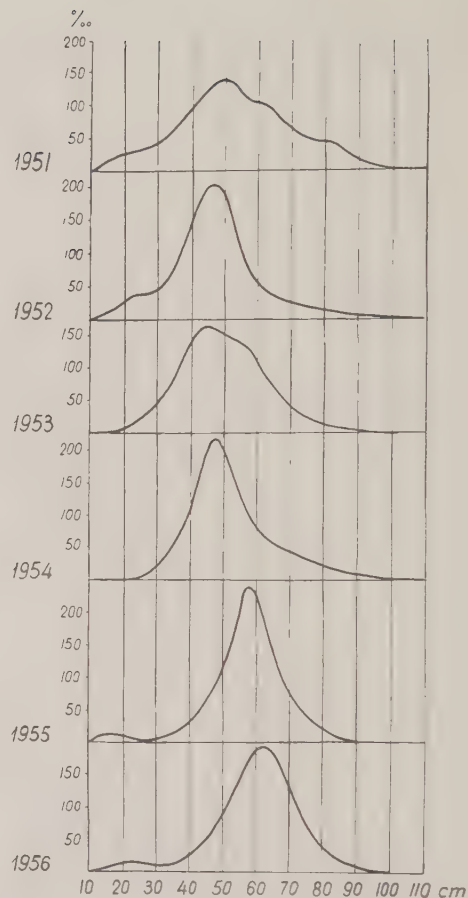


Figure 10. Size of cod in the north-western area.

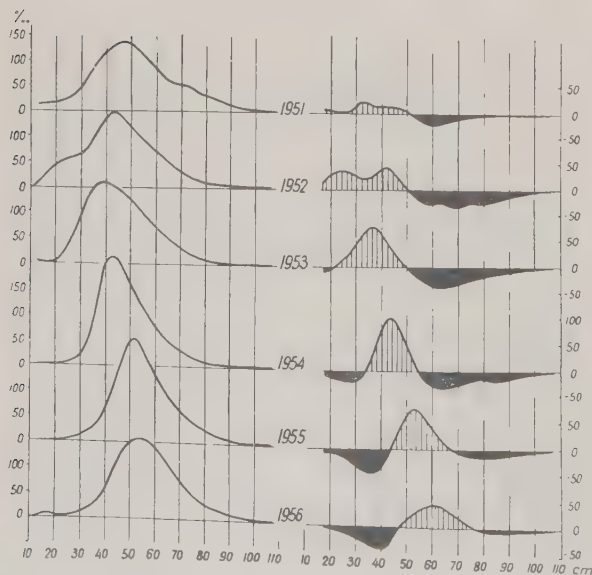


Figure 9. Cod: size distribution in the southern part of the Barents Sea. Right-hand side: the deviations from mean size frequencies for 1946—56.

sizes of cod in the southern part of the Barents Sea for 1951—1956. Graphs showing the deviations from the mean size frequencies for 1946—1956 are shown on the right. Figure 10 shows the sizes of cod in the north-western area.

From comparison of the size curves with the deviations shown in Figure 9 and the year-class distribution shown on the left-hand side of Figure 8, it may be seen that the curve for size of cod in the southern part of the Barents Sea in 1952 has a peak corresponding to an increase in the number of fish 20—30 cm. long, while the dominant year-classes in 1951 were those of 1947, 1946, and 1948, i.e., fish at the ages of 5+, 4+, and 3+; the same age categories, i.e., the year-classes of 1948, 1947, and 1949, are predominant in 1952 and a considerable number of fish at age 2+, i.e., fish of the 1950 year-class, appear in 1952, as may be clearly seen from the length curve and the graph of age composition for the southern part of the sea. Beginning with 1953, three year-classes predominate in the

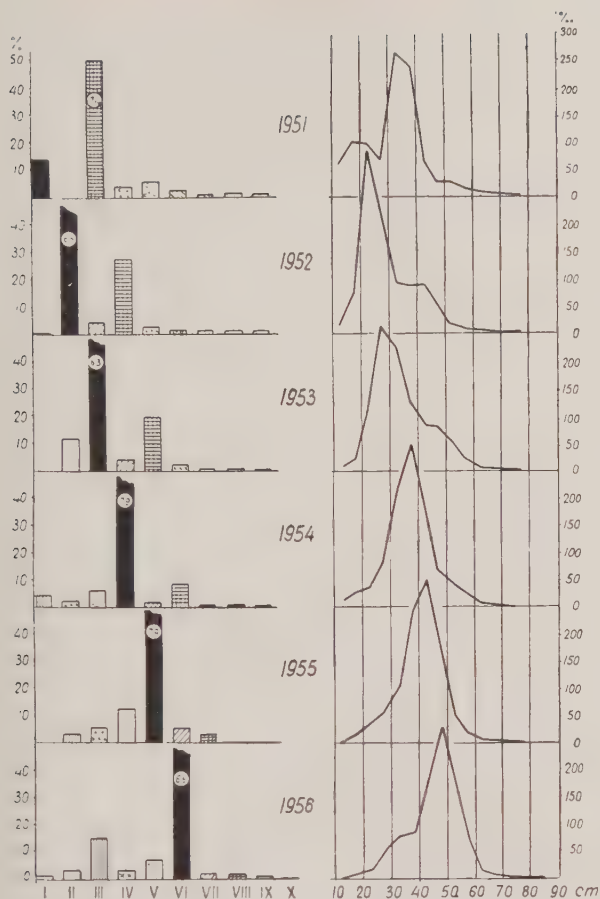


Figure 11. Haddock: age composition and size.

catches in respect of both number and weight of fish; these are 1950, 1949, and 1948. Doubtless the richest is the 1950 year-class, with the 1949 year-class a close second. In 1956, the same year-classes constituted the main bulk of the catch, but as regards numbers, the 1950 and 1949 broods clearly predominated, while the 1948 year-class was considerably weaker.

In the Bear Island-Spitsbergen region (except the region east and north-east of Hope Island) the variations in age composition are similar to those in the southern part of the sea, but there are certain differences. The 1948 year-class at the age of four, i.e., in 1952, constituted, in numbers, 50% of the whole catch, and its relative importance was greater than in the southern part of the sea in the two following years as well. The 1950 year-class also seemed to be the most numerous, while the 1951 year-class in 1955, i.e., at an age of four years, was more numerous than in the southern part of the sea. The 1946 and 1945 year-classes were weak in both the southern part of the sea and in the

Bear Island-Spitsbergen region, although the percentage of these year-classes in the catches was higher, while the 1947 year-class was of average abundance. When estimating the relative strength of the recruitment of various years, it is necessary to bear in mind that the year-classes beginning with 1937 have been subjected to fishing of varying intensity.

Figure 11 shows the age composition (left-hand columns) and length curves for haddock (on the right) in the southern part of the Barents Sea for 1951—1956. The predominance of two year-classes, 1948 and 1950, is clear. The first was relatively numerous only in 1951, i.e., at the age of 3+; the second has predominated since 1952 up to the present time, and from 1954 the fish of this year-class have constituted the main part of the weight of the catches. The age composition for every year-class, with the exception of the first half of 1956, was calculated in accordance with measurement data, as was done in the case of the cod. The year-classes from 1944 to 1946, inclusive, were very weak, the 1951 year-class must be regarded as average, and the 1949 and 1952 year-classes were very weak. The 1953 year-class, according to mass measurement data and otolith samples, must be regarded as very weak. However, as will be shown below, this estimate may be reconsidered on the basis of special investigations of the distribution and numbers of young fish.

It has already been mentioned that investigations of the variations in the stocks of cod and haddock

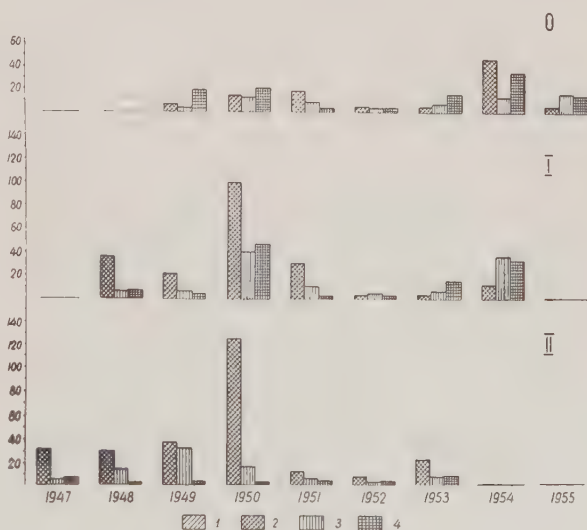


Figure 12. Catches of young cod in the southern part of the Barents Sea.

1. Western grounds.
2. Murman coast grounds.
3. Central grounds.
4. South-eastern grounds.



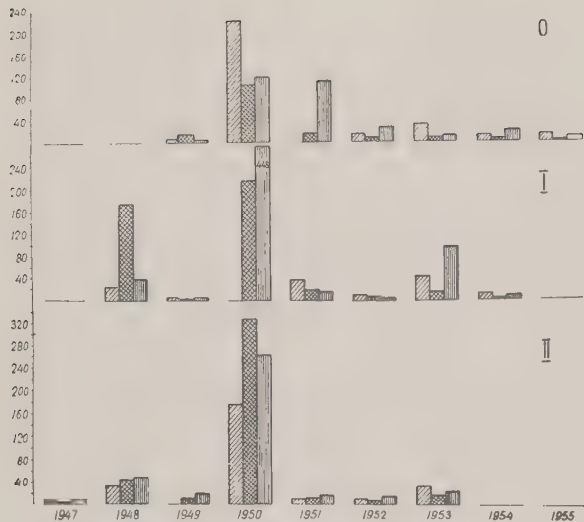


Figure 13. Catches of young haddock in the southern part of the Barents Sea. For symbols, see Figure 12.

were carried out in two ways, and one of these has been described above. The other method consists of studying the recruitment of the stocks by estimating the numbers of young cod and haddock caught in trawls with cod-ends fitted with fine-meshed netting, of mesh-size 8—10 mm. between knots. In this, all fish of up to 36 cm. long were taken into account. The work was carried out at the Polar Institute under the supervision of A. S. BARANENKOVA and a report on some of it will be published in the near future. The present report makes use of the data obtained during the winter months, principally from November to March. Catches in the southern part of the sea were recorded separately by sub-region and then summarized, as in the case of the north-western region. The figures for young cod and haddock given here (Figures 12 and 13) cover only the southern part of the sea.

In the table the height of the column represents the average number of young fish caught per 1-hour haul. The type of shading indicates the region to which the data apply. The catches of young haddock are given for three regions, western, central, and Murman coast; those of young cod are also given for three regions, south-eastern, central, and Murman coast. In the case of haddock large numbers of young fish settle on the bottom in the western region, and only few of them are carried by the currents into the south-eastern regions during the summer and the autumn. Cod fry, on the contrary, are carried far to the east (and north-east), only few of them settling down in the western region.

Thus the range of fluctuation of the average catches of young cod during the first year of life are from 2 to 44 fish in the central region, from 1(4) to 14 in coastal regions, from 1(3) to 32 in the south-eastern, and from 0.4 to 6 in the western region. Young haddock in the first year of life are only occasionally found in the south-eastern region, whereas in the western region the average catch per 1-hour haul varies from 5 to 215.

As is plainly seen from the graphs, there are substantial differences between the catches of young fish of both species in different years. In addition, there is undoubtedly a difference in distribution, as evidenced by the catches in different years in different regions. However, it should be borne in mind that not all the fish of group II were accounted for, but only those which did not exceed 36 cm. in length at the end of the third year.

The largest catches were of the 1950 brood, but the figure for haddock was considerably higher than that for cod, especially during the first year of life. An attempt could of course be made to draw more detailed conclusions about the distribution of the 0, I, and II groups of cod and haddock, but the incompleteness of the available data calls for circumspection in this respect. For the present we shall restrict ourselves to comparing the results obtained in this way with those obtained from examination of the age and size compositions found in the catches made without fine-mesh in the cod-end cover. Data are not available for the 1948 brood in its first year of life, but for the second and third years the results show that the young haddock and cod are evidently abundant in the central region and less so in coastal regions. As for the 1950 brood, a characteristic feature of the haddock brood is its extremely wide distribution; in the case of cod, it is noteworthy that the catch increases in the second year of life in all regions, and in the third year in the central regions only. Further, it may be seen that in the case of the 1949 year-class of cod the number of fish at the end of the first year of life caught per 1-hour haul was greatest in the eastern region;

Table 16. Average yearly catches of "large" cod per 1-hour haul by Soviet trawlers in the Barent Sea, in kilogrammes (round figures)

|                     |      |      |      |      |      |      |      |
|---------------------|------|------|------|------|------|------|------|
| Year                | 1930 | 1931 | 1932 | 1933 | 1934 | 1935 | 1936 |
| Kg. per 1-hour haul | 190  | 170  | 170  | 100  | 110  | 160  | 170  |
| Year                | 1937 | 1938 | 1939 | 1946 | 1947 | 1948 | 1949 |
| Kg. per 1-hour haul | 280  | 250  | 220  | 470  | 430  | 210  | 240  |
| Year                | 1950 | 1951 | 1952 | 1953 | 1954 | 1955 | 1956 |
| Kg. per 1-hour haul | 280  | 190  | 170  | 120  | 160  | >160 | >160 |



that of fish in the second year of life in the central regions; and that of fish in the third year, in the central and coastal regions. In view of the fact that relatively few young fish of this group were caught in the central and coastal regions, the evaluation of the brood strength at the time was not correct, and in later years it was estimated as being richer in comparison with the estimates made in the first and even the second years of its life. This is a striking example of the fact that the distribution in the first year of life should be studied in great detail, over as wide an area as possible. We see further that haddock of the 1953 year-class should be considered as of average abundance or rather above, while the broods of 1952 and, especially, 1949 are to be regarded as very weak. As judged by the results obtained during the first and second years of life, the 1954 year-class of cod is good but not so rich as the 1950 class. The 1952 year-class, as in the case of haddock, must be considered very poor.

It should be noted that our investigations give no grounds for supposing that the increased intensity of the trawl fishery for cod and the poor results of the Norwegian "skrei" fishery in 1953 and onwards have caused a decline in the recruitment of the stocks of cod in the southern part of the Barents Sea.

There are likewise insufficient grounds for concluding that the increased rate of fishing was the cause of the considerable decrease in the number of large mature cod since 1950. Table 16 gives the average yearly catches of large cod by Soviet trawlers, from 1930 onwards.

The cod which the trawlers call "large" are not quite the same as "skrei", as the designation "large" covers all fish longer than 70—75 cm. regardless of maturity. Nevertheless, a connexion might be established between the variations in the trawl catches of large cod, especially in the southern part of the sea, and the yearly variations in the catches of "skrei".

It can accordingly be expected that mature fish should be more abundant in 1957—1959 and that, consequently, the Norwegian catches of "skrei" should increase then, despite the large increase in the catches of young fish in recent years. There is also a marked regularity in the distribution of the catches by Soviet trawlers, depending on the age composition and the relative strengths of the year-classes of cod in the southern part of the Barents Sea. As has been previously shown, the year-classes of cod from 1944 to 1946 were poorer than in subsequent years, for example 1947 and especially 1948 to 1950. The catches of large and to a certain

extent of medium-sized fish were variable and, on the average, small during the greater part of the year, and for this reason fishing was carried on mostly in the coastal and central regions of the southern part of the sea. This is due to the fact that the bulk of the small fish which have been giving the largest catches since 1952 remain in those waters. This means, naturally, that the fishing of very small cod and haddock has been considerable, especially in the winter months.

Work on the distribution of the fish from the youngest upwards, and on improvement in census techniques constitutes one of the main fields of research covered by the Polar Institute of Marine Fisheries and Oceanography.

In addition to these investigations, a certain amount of work on similar problems is being carried on in coastal waters by the Murman Biological Station of the U.S.S.R. Academy of Sciences. Expansion of the future work of the Polar Institute in this direction will become possible primarily through the use of research vessels with longer cruising ranges, than, for instance, the "Persey-II".

N. MASLOV

### German Investigations

(Figure 14; Table 17)

The landings made by German vessels from the north-eastern area continued to increase; they rose from 92,259 tons in 1955 to 128,644 tons in 1956 and were double those of 1954. This extension of the fishery was caused by the presence of large shoals of cod and haddock, mainly off Bear Island, Spitsbergen, and the north-western Norwegian coast. In this locality 57,152 tons of cod were caught, which is more than double the amount in 1955.

Off the north-western Norwegian coast, the main fishing ground used by German trawlers in this locality, the cod catches rose from 12,335 to 22,620 tons, and the average daily catch throughout the year from 3.0 to 5.2 tons (see Figure 14). As in 1955, the 1948 year-class dominated, but the 1947 year-class, which held second place in 1955, was replaced by the younger classes of 1949 and 1950, which entered the Lofoten area in large shoals as first-time spawners. As a result of the rejuvenation of the spawning stock, the average length of the cod decreased from 81.8 to 75.6 cm. The mean lengths of the 3 strongest year-classes were 65.2 cm. (1950), 69.1 cm. (1949), and 79.5 cm. (1948).

Having fished only little in the Bear Island region in previous years, the German trawlers

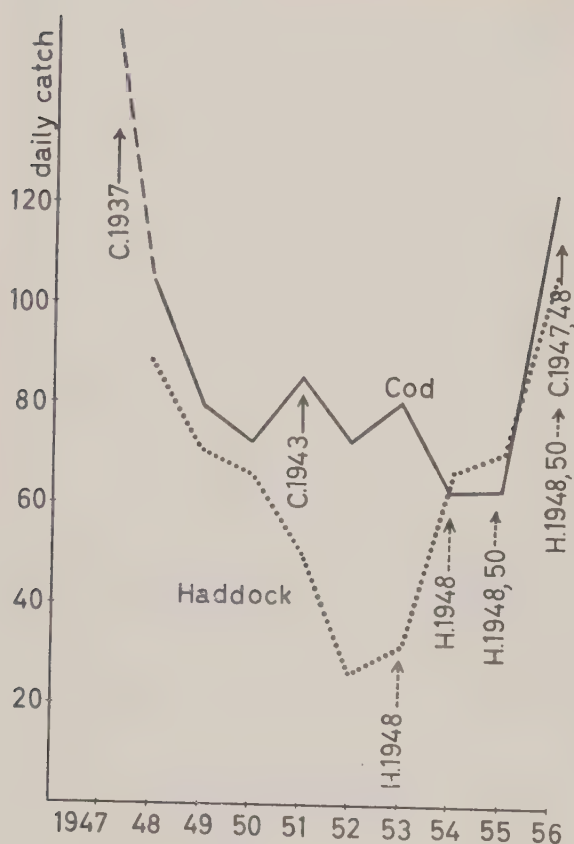


Figure 14. Daily cod and haddock catches (in 100-pound baskets) by German trawlers off the north-western Norwegian coast during the first 4 months of 1948–1956, showing the relation between the daily output of cod and haddock and the year-class strengths.

again developed considerable activity on these grounds in 1956, mainly from April to July, and in November and December. They took 18,117 tons of cod, that is, 67.9% of the total catch. The 1950 year-class predominated at 61.7%, i.e., the same proportion as in the preceding year. The average length of these cod, now 6 years old, increased from 60.0 to 64.0 cm. and that of the whole catch of cod from 63.6 to 65.2 cm. As a result of the larger cod of this year-class having left Bear Island for spawning, the mean length of the 1950 year-class on the Bear Island ground was somewhat smaller than off the Norwegian coast.

From June to November, mainly from June till August, a paying fishery for cod developed off Spitsbergen on Horn Sund Bank. The age composition of the stock was similar to that off Bear Island. The 1950 year-class predominated, with 49.1%, but the proportion of the five-year-old cod

Table 17. Age and length composition of cod on the north-eastern fishing grounds in 1956 (<sup>0</sup>/<sub>100</sub>)

|             | Norwegian coast<br>Jan.–April | Bear Island<br>April–July | Spitsbergen<br>Aug.–October | Barents Sea<br>Finnmark coast<br>June | Skolpen Bank<br>Nov.–Dec. |
|-------------|-------------------------------|---------------------------|-----------------------------|---------------------------------------|---------------------------|
| Length, cm. |                               |                           |                             |                                       |                           |
| 40–44       | 0                             | 2                         | 0                           | —                                     | —                         |
| 45–49       | 1                             | 20                        | 5                           | 30                                    | 3                         |
| 50–54       | 6                             | 79                        | 51                          | 152                                   | 51                        |
| 55–59       | 39                            | 164                       | 123                         | 316                                   | 152                       |
| 60–64       | 130                           | 269                       | 208                         | 191                                   | 247                       |
| 65–69       | 164                           | 224                       | 230                         | 139                                   | 210                       |
| 70–74       | 171                           | 125                       | 208                         | 83                                    | 128                       |
| 75–79       | 166                           | 65                        | 82                          | 45                                    | 81                        |
| 80–84       | 129                           | 31                        | 53                          | 20                                    | 48                        |
| 85–89       | 95                            | 13                        | 30                          | 12                                    | 39                        |
| 90–94       | 48                            | 5                         | 7                           | 5                                     | 18                        |
| 95–99       | 27                            | 3                         | 3                           | 3                                     | 12                        |
| 100–104     | 13                            | 0                         | 0                           | 2                                     | 8                         |
| 105–109     | 5                             | 0                         | 0                           | 1                                     | 2                         |
| 110–114     | 4                             | 0                         | —                           | 1                                     | 1                         |
| 115–119     | 2                             | 0                         | —                           | —                                     | —                         |
| Year-class  |                               |                           |                             |                                       |                           |
| 1953 ....   | 1                             | 1                         | —                           | —                                     | —                         |
| 1952 ....   | 1                             | 7                         | 10                          | —                                     | —                         |
| 1951 ....   | 12                            | 146                       | 282                         | 65                                    | 73                        |
| 1950 ....   | 213                           | 617                       | 491                         | 589                                   | 582                       |
| 1949 ....   | 192                           | 109                       | 77                          | 203                                   | 177                       |
| 1948 ....   | 460                           | 109                       | 131                         | 113                                   | 133                       |
| 1947 ....   | 76                            | 8                         | 8                           | 18                                    | 25                        |
| before 1947 | 45                            | 3                         | 1                           | 12                                    | 10                        |

was far greater off Spitsbergen than at Bear Island. Owing to the growth during the summer, the average length of the Spitsbergen cod was 2.7 cm. more than that of the Bear Island cod.

In contrast to all other north-eastern fishing grounds, fishing operations in the Barents Sea diminished in 1956 as compared with 1955. In the last two months of the year especially, the output of cod was particularly small (is this the first hint of the subsequent poor season at Lofoten, which was far worse than expected?). The age composition of Barents Sea cod was, as may be supposed, similar to that at Bear Island, but the growth of cod in the Barents Sea was somewhat less than on the western fishing grounds (1950 year-class: Bear Island 64.0 cm. in April–July; Spitsbergen 68.1 cm. in August–October; Skolpen Bank 63.8 cm. in November).

ARNO MEYER

**COD. FISHING GROUNDS OF DEEP AND GULF OF GDAŃSK**  
**AGE COMPOSITION 1946-1956**  
 WEIGHT RELATIONS %

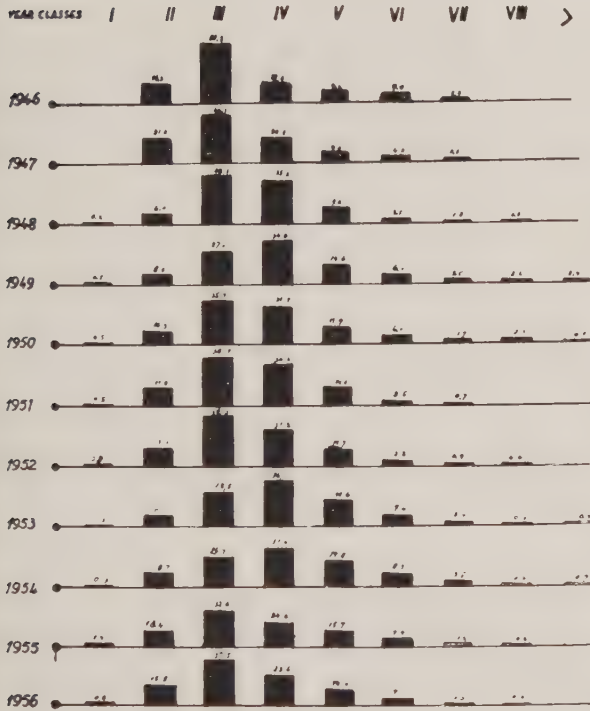


Figure 15.

**STRENGTH OF THE YEAR-CLASSES**  
**COD. FISHING GROUNDS OF DEEP AND GULF OF GDAŃSK**  
**AGE COMPOSITION 1946-1956**  
 WEIGHT RELATIONS %

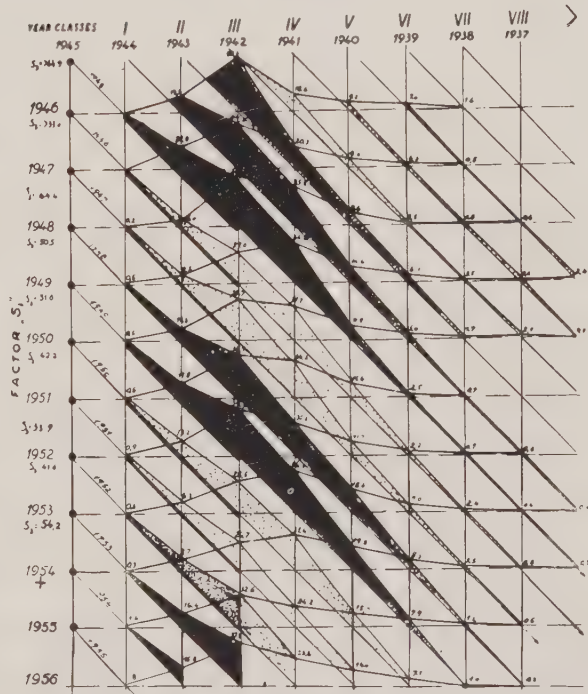


Figure 16.

### Baltic Stock

#### Age Composition of Cod in Polish Catches, in Gdansk Deep and Gdansk Bay, 1946—1956

(Figures 15 and 16)

The cod caught on the Gdansk grounds constitute on the average about 80% of the total Polish landings of cod from the Baltic (40,000—50,00 tons). Biometric analyses have shown that for the last 11 years the greater part of the weight of the annual Polish landings of cod from the Baltic comes from fish of age-groups III and IV. These as a rule make up 60—75% of the weight of the total catch. In the last 3 years, however, the proportion of these fish has declined, dropping below 60%, while at the same time the proportion of age-group II has risen. The changes in the percentage representation (by weight relation) of particular age-groups in the Polish cod landings from the Gdansk grounds are shown in Figure 16. This diagram illustrates the strength of the year-classes in a new manner, which is a modification of the usual method of employing histograms (Figure 15).

The curves represent the proportions of the various age-groups in the landings in a given year, and by joining the points indicating the proportion of a given age-group in successive years, we obtain a polygon which represents the strength of the year-class by an area.

It is apparent from the diagrams that the 1943, 1944, and 1945 year-classes were very numerous. We presume this was due to the reduction of fishing in the Baltic, and the Gdansk grounds in particular, in the final years of the war. The 1946 and later year-classes may be regarded as of medium strength, while that of 1949 was outstanding. The 1950 and 1951 year-classes were very poor; this was the period of the heaviest landings of cod from the Gdansk grounds. Polish landings of cod decreased considerably between 1953 and 1955; this may be linked with the poverty of the 1950 and 1951 year-classes. The 1953 and 1954 year-classes, on the other hand, appear to be very strong; this fact served as the basis for the forecasts of the fishery in 1956, 1957, and 1958. So far, this prognosis has been largely confirmed.



It seems that unfavourable environmental conditions (temperature and salinity) during the cod's spawning periods in 1956 and again in 1957 may result in a diminution of the number of recruits to the "industrial stock" in 1959—1961, and a decline in the Polish landings of cod is to be expected during this period.

STANISLAW RUTKOWICZ

### Age Composition of the Commercial Stock of Cod in 1956 and Estimated Number of Young Fish

(Tables 18—20)

The cod fishery in 1956 was in general very good, and monthly catches surpassed the long-period mean (Table 18).

The severe winter resulted in increased catches early in the year; as a result of the intense cooling of the coastal waters the immature cod collected with pre-spawning fish in relatively deep water. The main reason for the increase in the catches of cod, however, was the entry of the abundant 1953 year-class (3-year-olds) into the fishery. This is evident from Table 19.

The two previous year-classes (1952 and 1951) were considerably less abundant. The 1954 generation, on the contrary, was estimated to be even richer than that of 1953. The 1955 and 1956 year-classes were but feebly represented in the catches. However, at that time the work on the enumeration of the young cod was largely experimental in

Table 20. Average number of young cod caught per 1-hour haul at different depths (after TOKAREVA)

|               |              | Depth of haul (m.) |    |      |     |     |      |    |     |    |  |
|---------------|--------------|--------------------|----|------|-----|-----|------|----|-----|----|--|
| Year of catch |              | 7                  | 15 | 25   | 35  | 45  | 55   | 65 | 75  | 85 |  |
| Gdansk Bay    | January 1954 | 199                |    | 124  |     |     |      |    |     |    |  |
|               |              | 1953               |    |      |     |     |      |    |     |    |  |
|               | January 1955 | no fishing         |    |      |     |     | 700  |    | 480 |    |  |
|               |              | 1954               |    |      |     |     |      |    |     |    |  |
|               | January 1956 |                    |    |      |     |     | 528  |    | 156 |    |  |
|               |              | 1954               |    |      |     |     |      |    |     |    |  |
| Gdansk Bay    | January 1957 | 3                  |    |      |     | 100 | 55   | 36 |     |    |  |
|               |              | 1956               |    | 1955 |     |     |      |    |     |    |  |
|               | January 1954 | 56                 |    |      |     |     |      |    |     |    |  |
|               |              | 1953               |    |      |     |     |      |    | 18  |    |  |
|               |              | 1952               |    |      |     |     |      |    |     |    |  |
|               | January 1955 |                    |    |      |     | 270 |      |    |     |    |  |
| Klaipeda      |              | 1954               |    |      |     |     |      |    |     |    |  |
|               | January 1956 | 506                |    |      | 450 |     |      |    |     |    |  |
|               |              | 1954               |    |      |     |     | 1954 |    |     |    |  |
|               | January 1957 | 6                  | 47 |      |     | 36  |      |    |     |    |  |
|               |              | 1956               |    | 1955 |     |     | 1955 |    |     |    |  |

Note: Figures over the line are numbers of fish, under the line year-class.

character, and the available data must be regarded accordingly. Nevertheless, the data indicate that further increase can be expected in the catches of cod in 1957 and 1958.

It may be seen from Table 20 that in winter yearling cod keep to a depth of 15 to 20 m.

T. DEMENTJEVA

Table 18. Average catches of cod per 1-hour haul in kg. (after PRIEDITIS)

| Month                  | I   | II  | III | IV  | V   | VI  | VII | VIII | IX  | X   | XI  | XII |
|------------------------|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|-----|
| Gothland Deep          |     |     |     |     |     |     |     |      |     |     |     |     |
| 1956 catch .....       | —   | 110 | 280 | 276 | 250 | 120 | —   | —    | —   | —   | —   | —   |
| Long-period mean ..... | —   | 124 | 227 | 202 | 184 | 107 | —   | —    | —   | —   | —   | —   |
| Liepaja - Ventspils    |     |     |     |     |     |     |     |      |     |     |     |     |
| 1956 catch .....       | 144 | 180 | 260 | 200 | 160 | 100 | 130 | 128  | 125 | 126 | 170 | 140 |
| Long-period mean ..... | 117 | 175 | 210 | 115 | 114 | 89  | 101 | 110  | 100 | 108 | 132 | 125 |

Table 19. Percentage age composition of cod in Gothland Deep in 1955 and 1956 (after PRIEDITIS)

| Year of catch          | Age | 2   | 3    | 4    | 5    | 6    | 7   | 8   | 9   | Number of specimens |
|------------------------|-----|-----|------|------|------|------|-----|-----|-----|---------------------|
| March—April 1955 ..... |     | 3.4 | 19.0 | 39.0 | 17.0 | 15.2 | 5.1 | 1.3 | —   | 557                 |
| March—May 1956 .....   |     | 5.3 | 34.0 | 30.0 | 17.0 | 9.5  | 2.4 | 1.2 | 0.4 | 483                 |



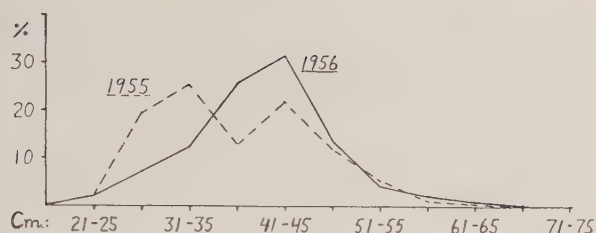


Figure 17. Length distribution of cod caught by hand-line in depths of 25—40 m. in the western Åland Sea in 1955 and 1956. 548 fish were measured in 1955 and 579 in 1956.

### Swedish Cod Tagging in the Baltic

(Figures 17 and 18)

In 1955 and 1956, 827 cod were tagged in the Åland Sea (219 in 1955 and 525 in 1956) and in the north-western part of the Bothnian Sea, S. E. of Örnsköldsvik (83 in 1956). The last experiment (82 cod tagged in November) has so far given no recoveries (1. April 1957). Tagging in the Åland Sea was carried out in the second half of August and the beginning of September and has resulted in 45 recaptures (6%).

Ebonite disks, marked SvÖ and a number, and Lea tags, with bridle and pin, were used (591 and 236 respectively). The disks were attached to the outer part of the gill-cover, the Lea tags to the musculature in front of the first dorsal fin. The fish were caught with hand-lines at a depth of 25—40 m. or (in the Bothnian Sea,) with long-lines (depth 35—110 m.). They were liberated immediately after being tagged and measured. Scale samples were taken for age determination.

Comparison of the two methods of tagging shows that the Lea tag is the more effective; for instance, after 7 months 303 ebonite disks gave 3% recaptures, while the returns in the same experiment for 222 Lea tags is 7.7%. The difference is no doubt due to the fact that the latter are more easily noticed by the fishermen and "interest" them more. Possibly also there is a higher mortality with ebonite disks, especially when used on young fish.

The length distribution of the fish caught by hand-line in the Åland Sea is shown in Figure 17. The III and IV age-groups predominate. Obviously the stock of the younger fish in the area was larger in 1955 than in 1956.

The positions of recoveries from the two experiments in the Åland Sea are shown in the chart, Figure 18. Well over 25% of the recaptures were made in the southern and central Baltic. Of course the records illustrate fishing activity to some extent. The Swedish cod fishery from south of the



Figure 18. Recoveries up to 1. April 1957, from Swedish cod tagging experiments in the Åland Sea. Arrows indicate the tagging localities. The figures show the numbers of recaptures in the immediate neighbourhood; the other records are shown separately.

- = recoveries from the 1955 experiment.
- = recoveries from the 1956 experiment.

Åland Sea to west of Gothland is very small. In the Åland Sea itself we have a fairly intensive line-fishery. North of this region, in the Gulf of Bothnia there is no cod fishery worth mentioning, except one on a small scale in the deep water off the coast of Ångermanland. The most intensive fishery is carried on in the southern part of the Baltic. The absence of records from northern localities—exclusive of an isolated instance from the Finnish coast—might thus be explained to some extent as a result of low fishing activity. The stock of cod in the northern regions is usually small, however.

The recaptures in the southern Baltic were made in the period February—June, after the tagging in the preceding August—September. There is also one record for February 1½ years after tagging. The two recoveries in the central Baltic were made in December and March. Most of the recaptures in the Åland Sea were made in September and October, and some were made in the winter months. None was reported from this region in summer. The long-line fishery there is carried on throughout the year when not prevented by ice (as usually happens one month in the year).

The present material does not enable any conclusions to be drawn regarding a possible distinction between the cod which migrate south-

wards and those which remain in the Åland Sea. The cod recaptured in the southern and central Baltic ranged between 34 and 49 cm. when tagged. The lengths of the fish recovered in the autumn may indicate a smaller growth in 1956 than in 1955 for the Åland Sea. The material available is scanty, however.

Obviously there is a considerable movement of cod between regions far apart in the Baltic. Possibly the cod population of the Åland Sea and the areas northwards is recruited from the central and southern Baltic, many of these fish later returning southwards. Hauls with plankton and

strawin nets in the course of the tagging experiments in the Åland Sea yielded neither eggs nor fry. The spawning of the cod was proceeding actively however, as judged from the maturity stages of the fish caught at depths of 200—250 m. In the Gulf of Bothnia off the Ångermanland coast spawning stages were noticed in July at a depth of about 100 m. As a result of the low salinity even in the depths, it is possible that no larvae develop from the eggs spawned by the cod in these regions.

GUNNAR OTTERLIND

## HADDOCK

### Iceland Stock

#### German Investigations

(Table 21)

Since 1950, the haddock catches have never been so high as in 1956, in spite of the fact that at the same time extremely good catches of haddock off the Norwegian coast restricted the Icelandic haddock landings. Otherwise, the output of Icelandic haddock would have been even larger. Most of the 7,292 tons of haddock (75.2%), which amounted to 5.9% of the total German trawler catches in Icelandic waters, were caught south-west and south of the island, mainly in April. The sudden increase in the yield of haddock was caused by the succession of 3 rich year-classes, namely 1949, 1950, and 1951; these together amounted to 88.2% of the total catch. The average length of all haddock was 58.0 cm., that of the 3 predominant year-classes 65.3 cm. (1949), 60.3 cm. (1950), and 54.7 cm. (1951). The 1952 year-class was also well represented on the grounds south-east of Iceland.

Table 21. Age and length of the haddock on the fishing grounds off the S.W., S., and S.E. coasts of Iceland in 1956 (<sup>0</sup>/<sub>00</sub>)

| Length, cm.       | S.W. and S. coast<br>February—April | S.E. coast<br>December |
|-------------------|-------------------------------------|------------------------|
| 35—39 .....       | 1                                   | —                      |
| 40—44 .....       | 37                                  | 14                     |
| 45—49 .....       | 120                                 | 20                     |
| 50—54 .....       | 199                                 | 124                    |
| 55—59 .....       | 267                                 | 303                    |
| 60—64 .....       | 201                                 | 296                    |
| 65—69 .....       | 126                                 | 105                    |
| 70—74 .....       | 36                                  | 104                    |
| 75—79 .....       | 11                                  | 28                     |
| 80—84 .....       | 2                                   | 3                      |
| 85—89 .....       | 0                                   | 3                      |
| Year-class        |                                     |                        |
| 1954 .....        | —                                   | 23                     |
| 1953 .....        | 1                                   | 86                     |
| 1952 .....        | 75                                  | 380                    |
| 1951 .....        | 362                                 | 206                    |
| 1950 .....        | 333                                 | 216                    |
| 1949 .....        | 197                                 | 83                     |
| before 1949 ..... | 32                                  | 6                      |

ARNO MEYER

Arcto-Norwegian Stock<sup>1)</sup>

## German Investigation

(Table 22)

The improvement in the catches of haddock in the north-eastern area in 1954 and 1955 and the further increase in 1956 were caused by the two outstanding year-classes of 1948 and 1950. The yield of haddock rose to 22,106 tons (15,502 tons in 1955), that is 17.2% of the total catch of German trawlers in the north-eastern area.

18,112 tons of haddock (81.9%) were caught off the Norwegian coast mainly in February, March, and April. Whereas in 1955, 73.4% of the spawning stock consisted of 7-year-old haddock, the 1948 year-class was replaced in 1956 by the younger 1950 year-class. The average length of haddock accordingly decreased from 59.3 to 56.3 cm. The mean length of the 1948 year-class off Lofoten

rose during the last two seasons from 58.9 to 62.7 cm. and that of the 1950 year-class from 53.5 to 55.2 cm.

In the Barents Sea off the Finnmark coast and on Skolpen and Tidly Banks, more than 80% of the haddock belonged to the 1950 year-class. The proportion of 6-year-old haddock was lower and that of the younger year-classes greater in the waters off Bear Island and South Spitsbergen than in the Barents Sea. The haddock of the Bear Island region are growing faster than those on the eastern fishing grounds. The mean length of the 6-year-old Bear Island haddock was already 55.9 cm. by May, whereas in the Barents Sea fish of the same age were considerably smaller, even after one more feeding season (Finnmark coast in June, 48.2 cm.; Skolpen Bank in November, 48.6 cm.; and Tidly Bank in December, 51.3 cm.).

ARNO MEYER

Table 22. Age and length composition of haddock on the north-eastern fishing grounds in 1956 (‰)

| Length,<br>cm. | Nor-<br>wegian<br>coast | Bear<br>Island | Spits-<br>bergen | Barents Sea            |                           |
|----------------|-------------------------|----------------|------------------|------------------------|---------------------------|
|                |                         |                |                  | Finn-<br>mark<br>coast | Skolpen-<br>Tidly<br>Bank |
|                | Febr.-April             | May            | October          | June                   | Nov.-<br>Dec.             |
| 30—34          | —                       | —              | —                | —                      | 4                         |
| 35—39          | 1                       | 2              | 55               | 18                     | 53                        |
| 40—44          | 14                      | 36             | 361              | 249                    | 185                       |
| 45—49          | 127                     | 198            | 192              | 435                    | 353                       |
| 50—54          | 317                     | 319            | 19               | 238                    | 293                       |
| 55—59          | 292                     | 282            | 87               | 44                     | 77                        |
| 60—64          | 161                     | 122            | 130              | 10                     | 15                        |
| 65—69          | 64                      | 34             | 50               | 5                      | 9                         |
| 70—74          | 15                      | 5              | 22               | 1                      | 3                         |
| 75—79          | 4                       | 1              | 25               | —                      | 2                         |
| 80—84          | 4                       | 1              | 39               | —                      | 5                         |
| 85—89          | 1                       | —              | 20               | —                      | 1                         |
| 90—94          | 0                       | —              | —                | —                      | —                         |
| Year-class     |                         |                |                  |                        |                           |
| 1953 ....      | 13                      | 12             | —                | —                      | 6                         |
| 1952 ....      | 1                       | 79             | —                | 7                      | 9                         |
| 1951 ....      | 23                      | 302            | —                | 125                    | 92                        |
| 1950 ....      | 606                     | 523            | —                | 821                    | 840                       |
| 1949 ....      | 44                      | 5              | —                | 36                     | 20                        |
| 1948 ....      | 294                     | 65             | —                | 11                     | 24                        |
| before 1948    | 19                      | 14             | —                | 0                      | 9                         |

<sup>1)</sup> Soviet Investigations on the Arcto-Norwegian Stock of Haddock, see pp. 141-45.

## Faroe Stock

## Scottish Investigations

(Tables 23-24)

Market sampling of the Faroe haddock stock was continued as in previous years and the data are given in Table 23 (p. 151).

## Age composition

The age composition of haddock sampled from commercial trawlers is shown in Table 23A. The mean lengths of each brood are given in Table 23B, and in Table 23C are shown the estimated weights of each brood landed per 10 hours' fishing each month. These were determined by converting the mean lengths in Table 23B to weights (using data from RUSSELL, 1914<sup>2)</sup>) and then multiplying each by the appropriate numbers per 10 hours' fishing from Table 23A. As in previous years, the younger broods (ages II-V) made up the greater part of the landings.

<sup>2)</sup> RUSSELL, E. S. (1914), Fish. Invest., Lond., Ser. 2, 1 (1).

Table 23. Aberdeen trawlers' market samples — Faroe haddock — 1956

| Brood    | A. Number landed/10 hours fishing |         |        |         |         |         |         |         |         |         |         |         |
|----------|-----------------------------------|---------|--------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
|          | Jan.                              | Feb.    | Mar.   | April   | May     | June    | July    | Aug.    | Sept.   | Oct.    | Nov.    | Dec.    |
| 1955 ... | —                                 | —       | —      | —       | —       | —       | —       | —       | —       | 20.52   | 74.56   | 33.84   |
| 1954 ... | 73.92                             | 15.78   | 22.31  | —       | 85.42   | 132.16  | 304.63  | 259.72  | 665.86  | 656.59  | 845.84  | 582.82  |
| 1953 ... | 1577.84                           | 1023.21 | 587.29 | 1148.10 | 983.22  | 952.16  | 1073.70 | 697.36  | 969.52  | 535.94  | 528.38  | 573.59  |
| 1952 ... | 153.30                            | 49.94   | 91.57  | 211.20  | 152.21  | 140.41  | 197.57  | 162.37  | 57.37   | 25.10   | 8.68    | 38.93   |
| 1951 ... | 35.32                             | 15.07   | 31.12  | 70.00   | 54.48   | 46.06   | 34.63   | 48.06   | 22.57   | 9.31    | 3.47    | 9.16    |
| 1950 ... | 15.57                             | 11.50   | 17.37  | 30.98   | 12.64   | 25.07   | 27.68   | 26.40   | 13.59   | 5.74    | 3.31    | 4.41    |
| 1949 ... | 10.04                             | 7.84    | 13.44  | 15.52   | 18.57   | 10.63   | 16.10   | 17.74   | 12.65   | 5.38    | 2.40    | 5.06    |
| 1948 ... | 3.47                              | 4.73    | 7.97   | 13.01   | 9.25    | 9.25    | 19.60   | 11.94   | 3.42    | 2.89    | 1.54    | 1.51    |
| 1947 ... | 4.01                              | 4.68    | 4.30   | 2.43    | 2.04    | 4.14    | 13.04   | 8.80    | 2.31    | 0.39    | 0.93    | 1.52    |
| 1946 ... | 0.35                              | 0.62    | 1.03   | 0.14    | 2.56    | 0.14    | 2.32    | 0.50    | —       | —       | 0.66    | —       |
| 1945 ... | 2.31                              | 2.36    | 3.00   | 1.82    | 5.05    | 3.68    | 8.37    | 2.51    | 1.67    | 2.06    | 0.16    | 0.08    |
| 1944 ... | 0.45                              | 1.64    | 0.21   | 0.38    | 1.58    | 0.35    | 5.18    | 0.50    | —       | 0.34    | 0.66    | —       |
| 1943 ... | —                                 | —       | 0.23   | 0.20    | 0.30    | 0.19    | —       | —       | —       | —       | —       | 0.24    |
| 1942 ... | —                                 | —       | —      | —       | 0.13    | 0.22    | —       | —       | —       | —       | —       | —       |
| Total .. | 1876.58                           | 1137.37 | 779.84 | 1493.78 | 1327.45 | 1324.46 | 1702.82 | 1235.90 | 1748.96 | 1264.26 | 1470.59 | 1251.16 |

## B. Mean lengths of each age-group sampled

|          |       |       |       |       |       |       |       |       |       |       |       |       |
|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1955 ... | —     | —     | —     | —     | —     | —     | —     | —     | —     | 32.85 | 32.59 | 34.23 |
| 1954 ... | 31.69 | 32.30 | 32.02 | —     | 33.26 | 33.32 | 34.67 | 35.99 | 36.92 | 38.19 | 38.85 | 38.86 |
| 1953 ... | 37.77 | 40.73 | 39.76 | 39.56 | 39.78 | 40.72 | 40.30 | 43.05 | 44.56 | 46.20 | 45.59 | 46.09 |
| 1952 ... | 49.95 | 51.08 | 49.44 | 47.54 | 49.31 | 49.17 | 49.24 | 49.13 | 49.69 | 53.76 | 54.52 | 53.50 |
| 1951 ... | 55.96 | 54.71 | 54.77 | 54.82 | 54.75 | 55.28 | 55.39 | 55.06 | 58.92 | 61.00 | 59.35 | 59.14 |
| 1950 ... | 61.21 | 61.36 | 60.20 | 59.33 | 60.46 | 58.81 | 61.68 | 62.92 | 64.21 | 62.42 | 63.56 | 64.21 |
| 1949 ... | 65.32 | 62.61 | 64.20 | 63.66 | 64.32 | 65.84 | 66.72 | 64.08 | 66.52 | 68.29 | 66.60 | 66.82 |
| 1948 ... | 65.58 | 66.17 | 67.87 | 65.16 | 67.08 | 68.52 | 67.08 | 67.71 | 67.67 | 68.01 | 70.00 | 69.75 |
| 1947 ... | 72.59 | 67.93 | 66.52 | 69.38 | 70.50 | 69.81 | 70.08 | 69.69 | 71.75 | 71.50 | 69.78 | 69.62 |
| 1946 ... | 72.00 | 68.50 | 68.00 | 65.00 | 70.78 | 77.00 | 71.50 | 77.00 | —     | —     | 72.00 | —     |
| 1945 ... | 71.72 | 72.46 | 71.75 | 74.39 | 69.57 | 70.26 | 76.00 | 68.83 | 69.00 | 73.40 | 72.00 | 66.00 |
| 1944 ... | 76.00 | 74.12 | 72.50 | 79.00 | 71.33 | 79.50 | 73.25 | 74.00 | —     | 77.00 | 74.50 | —     |
| 1943 ... | —     | —     | 70.00 | 80.00 | 71.00 | 83.00 | —     | —     | —     | —     | —     | 71.00 |
| 1942 ... | —     | —     | —     | —     | 88.00 | 84.00 | —     | —     | —     | —     | —     | —     |

C. Estimated weights<sup>1)</sup> landed/10 hours fishing (in cwt.)

|          |       |       |      |       |       |       |       |       |       |       |       |       |
|----------|-------|-------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1955 ... | —     | —     | —    | —     | —     | —     | —     | —     | —     | 0.12  | 0.43  | 0.22  |
| 1954 ... | 0.37  | 0.08  | 0.11 | —     | 0.49  | 0.78  | 2.09  | 2.02  | 5.60  | 6.23  | 8.48  | 5.76  |
| 1953 ... | 14.01 | 10.92 | 5.65 | 11.12 | 9.95  | 10.72 | 11.77 | 9.44  | 14.54 | 9.12  | 8.67  | 9.65  |
| 1952 ... | 3.32  | 1.11  | 0.94 | 3.54  | 2.88  | 2.76  | 3.95  | 3.30  | 1.20  | 0.68  | 0.25  | 1.06  |
| 1951 ... | 1.07  | 0.40  | 0.77 | 1.80  | 1.43  | 1.31  | 1.01  | 1.40  | 0.81  | 0.38  | 0.13  | 0.34  |
| 1950 ... | 0.63  | 0.45  | 0.58 | 1.04  | 0.46  | 0.86  | 1.12  | 1.13  | 0.62  | 0.24  | 0.15  | 0.20  |
| 1949 ... | 0.47  | 0.32  | 0.53 | 0.67  | 0.79  | 0.48  | 0.79  | 0.81  | 0.62  | 0.28  | 0.13  | 0.26  |
| 1948 ... | 0.16  | 0.24  | 0.34 | 0.59  | 0.40  | 0.54  | 0.97  | 0.65  | 0.17  | 0.15  | 0.09  | 0.09  |
| 1947 ... | 0.28  | 0.24  | 0.19 | 0.44  | 0.11  | 0.25  | 0.74  | 0.50  | 0.11  | 0.02  | 0.06  | 0.09  |
| 1946 ... | 0.02  | 0.03  | 0.04 | 0.01  | 0.14  | 0.01  | 0.13  | 0.03  | —     | —     | 0.04  | —     |
| 1945 ... | 0.14  | 0.15  | 0.16 | 0.11  | 0.27  | 0.22  | 0.48  | 0.14  | 0.08  | 0.11  | 0.01  | 0.00  |
| 1944 ... | 0.03  | 0.10  | 0.01 | 0.02  | 0.09  | 0.02  | 0.30  | 0.03  | —     | 0.02  | 0.04  | —     |
| 1943 ... | —     | —     | 0.01 | 0.01  | 0.02  | 0.01  | —     | —     | —     | —     | —     | 0.01  |
| 1942 ... | —     | —     | —    | —     | 0.01  | 0.02  | —     | —     | —     | —     | —     | —     |
| Total .. | 20.50 | 14.04 | 9.33 | 19.35 | 17.04 | 17.98 | 23.35 | 19.45 | 23.75 | 17.35 | 18.48 | 17.68 |

Actual  
landings per  
10 hours by  
Aberdeen  
trawlers

17.50 13.43 10.05 18.35 17.25 17.47 21.81 19.14 23.37 16.63 18.46 17.19

<sup>1)</sup> Estimated using data from RUSSELL, 1914.

An interesting thing about the mean lengths of the younger fish (ages II-VI) is that there was a tendency for these to show a decrease during the spawning season between March and April. The amount of decrease is very small and, from these

data alone, not very convincing. However, the same thing has happened every year since 1950, when market sampling of Faroe haddock commenced and so, after occurring seven years running, it seems worthy of mention.



Table 24. Landings of three size categories by Aberdeen trawlers from Faroe — 1956  
Cwt. per 100 Hours

| Month        | Hours fishing | Extra large and large | Medium | Small | Total |
|--------------|---------------|-----------------------|--------|-------|-------|
| January .... | 4030          | 35.5                  | 51.5   | 88.0  | 175.0 |
| February ... | 6531          | 38.2                  | 42.8   | 53.3  | 134.3 |
| March .....  | 8375          | 25.9                  | 31.6   | 43.0  | 100.5 |
| April .....  | 5691          | 47.7                  | 62.4   | 73.4  | 183.5 |
| May .....    | 4386          | 40.7                  | 47.6   | 84.2  | 172.5 |
| June .....   | 6342          | 43.7                  | 57.0   | 74.0  | 174.7 |
| July .....   | 8255          | 48.4                  | 76.6   | 93.1  | 218.1 |
| August ..... | 7796          | 50.5                  | 66.2   | 74.7  | 191.4 |
| September .. | 5032          | 48.7                  | 84.8   | 100.2 | 233.7 |
| October .... | 4126          | 32.5                  | 72.2   | 61.6  | 166.3 |
| November ..  | 6210          | 30.4                  | 77.7   | 76.5  | 184.6 |
| December ... | 4905          | 30.7                  | 75.2   | 66.0  | 171.9 |
| Total/Mean.. | 71,679        | 39.7                  | 61.5   | 72.9  | 174.1 |

The average weights of haddock, per 100 hours' fishing, landed by Aberdeen trawlers from Faroe during 1956 are shown in Table 24. The mean catch per 100 hours' fishing (174.1 cwt.) compares

favourably with that of 167.3 cwt. in 1955 and continues the apparent upward trend that started at 124.8 cwt. in 1952.

R. JONES, W. MAIN

## North Sea Stock

## German Investigations

(Figures 19–20; Tables 25–27)

Data on the haddock stock of the North Sea were obtained on four cruises with the F.R.S. "Anton Dohrn" in February/March, April, September, and October 1956. As in the preceding year sampling was carried out exclusively by means of the ordinary herring trawl (180 feet), each haul being of half an hour's duration.

## Age composition and mean length

The age compositions of the haddock stocks sampled by the "Anton Dohrn" in different parts of the North Sea are given in Table 25–27 (upper

Table 25. Mean catch per 10 hours trawling (number of fish) and age composition (%) of haddock caught by the F.R.S. "Anton Dohrn" in the North Sea in February/March 1956

| Age-group           | Year-class | Jutland Bank | Egersund-Klondyke | Ling Bank  | Utsira Ground | Viking Bank  | Bressay Shoal | West of Shetlands | Svinøy     |
|---------------------|------------|--------------|-------------------|------------|---------------|--------------|---------------|-------------------|------------|
| 0                   | 1955       | 3530 (99)    | 1127 (96)         | 1800 (56)  | 2649 (71)     | 8230 (80)    | 25,340 (69)   | 20 (1)            | 4260 (56)  |
| I                   | 1954       | 10 (0.7)     | 27 (2)            | 1000 (31)  | 722 (19)      | 1009 (10)    | 10,920 (29)   | 282 (15)          | 1460 (20)  |
| II                  | 1953       | —            | 20 (2)            | 330 (10)   | 229 (6)       | 436 (4)      | 470 (1.4)     | 630 (33)          | 1680 (22)  |
| III                 | 1952       | 3 (0.3)      | —                 | 80 (2)     | 93 (3)        | 415 (4)      | 200 (0.5)     | 676 (35)          | 80 (1)     |
| IV                  | 1951       | —            | —                 | 10 (1)     | 13 (1)        | 125 (1)      | 30 (0.1)      | 252 (13)          | 60 (0.5)   |
| V                   | 1950       | —            | —                 | —          | —             | 25 (0.5)     | —             | 40 (2)            | 60 (0.5)   |
| VI                  | 1949       | —            | —                 | —          | —             | 7 (0.3)      | —             | 16 (0.8)          | —          |
| VII+                | 1948+      | —            | —                 | —          | —             | 2 (0.2)      | —             | 2 (0.2)           | —          |
| All ages .....      |            | 3543 (100)   | 1174 (100)        | 3220 (100) | 3706 (100)    | 10,249 (100) | 36,960 (100)  | 1918 (100)        | 7600 (100) |
| Trawl stations .... |            | 6            | 3                 | 2          | 9             | 11           | 2             | 10                | 1          |

## Mean lengths (cm.)

|     |      | Jutland Bank  |       |             | Ling Bank         |       |             | Utsira Ground |       |             | Viking Bank |       |             |
|-----|------|---------------|-------|-------------|-------------------|-------|-------------|---------------|-------|-------------|-------------|-------|-------------|
|     |      | Mean          | Range | No. of fish | Mean              | Range | No. of fish | Mean          | Range | No. of fish | Mean        | Range | No. of fish |
| 0   | 1955 | 17.3          | 12–25 | 795         | 16.2              | 12–21 | 180         | 16.9          | 13–21 | 572         | 16.4        | 13–21 | 1860        |
| I   | 1954 | (25.0)        | 25    | 3           | 27.6              | 22–32 | 100         | 26.8          | 22–35 | 289         | 27.9        | 21–35 | 353         |
| II  | 1953 | —             | —     | —           | 32.4              | 26–41 | 33          | 34.0          | 26–46 | 91          | 35.4        | 23–46 | 186         |
| III | 1952 | —             | —     | —           | (40.6)            | 30–43 | 8           | 40.0          | 29–49 | 37          | 40.3        | 29–54 | 187         |
| IV  | 1951 | —             | —     | —           | (40.0)            | —     | 1           | (46.0)        | 42–52 | 6           | 42.9        | 35–61 | 64          |
| V   | 1950 | —             | —     | —           | —                 | —     | —           | —             | —     | —           | 50.3        | 46–59 | 11          |
| VI  | 1949 | —             | —     | —           | —                 | —     | —           | —             | —     | —           | (55.2)      | 47–62 | 4           |
| VII | 1948 | —             | —     | —           | —                 | —     | —           | —             | —     | —           | (63.0)      | —     | 1           |
|     |      | Bressay Shoal |       |             | West of Shetlands |       |             | Svinøy        |       |             |             |       |             |
|     |      | Mean          | Range | No. of fish | Mean              | Range | No. of fish | Mean          | Range | No. of fish |             |       |             |
| 0   | 1955 | 16.0          | 11–20 | 692         | (16.0)            | 16–20 | 7           | 16.1          | 14–22 | 206         |             |       |             |
| I   | 1954 | 26.0          | 22–27 | 290         | 26.8              | 22–33 | 85          | 21.4          | 20–28 | 73          |             |       |             |
| II  | 1953 | (29.5)        | 28–32 | 4           | 31.3              | 25–41 | 161         | 28.0          | 22–38 | 84          |             |       |             |
| III | 1952 | (32.4)        | 28–34 | 7           | 36.6              | 28–52 | 130         | (40.0)        | 31–51 | 4           |             |       |             |
| IV  | 1951 | (36.0)        | —     | 1           | 42.5              | 33–59 | 80          | (46.3)        | 36–59 | 3           |             |       |             |
| V   | 1950 | —             | —     | —           | 50.7              | 45–67 | 15          | (46.3)        | 42–52 | 3           |             |       |             |
| VI  | 1949 | —             | —     | —           | (50.7)            | 45–53 | 6           | —             | —     | —           |             |       |             |
| VII | 1948 | —             | —     | —           | —                 | —     | —           | —             | —     | —           |             |       |             |

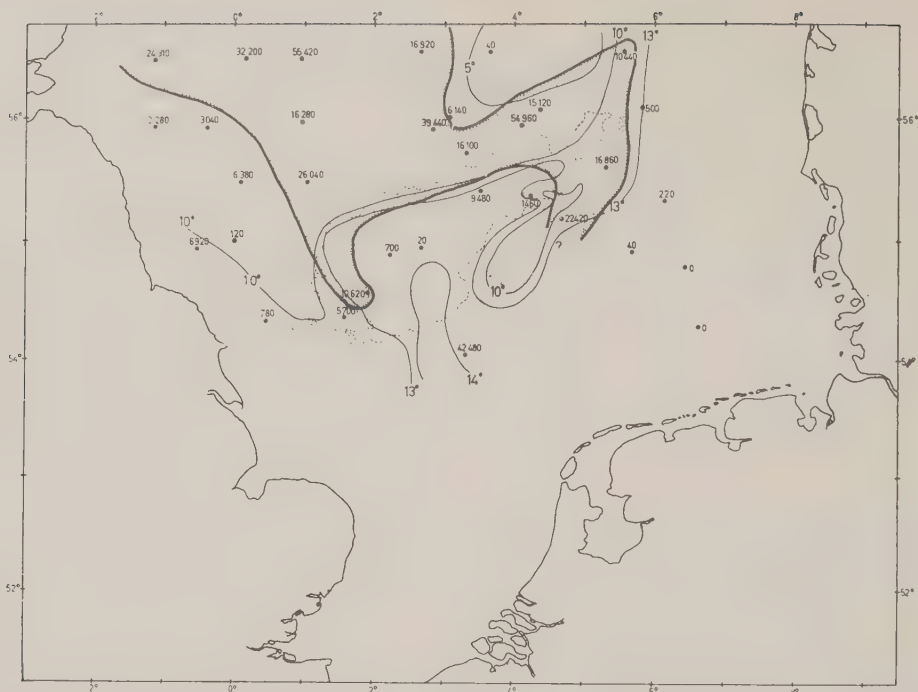


Figure 19. Number of haddock caught per 10 hours trawling by the F.R.S. "Anton Dohrn" in September 1956 and bottom isotherms (the isoline for 10,000 haddock per 10 hours trawling is drawn).

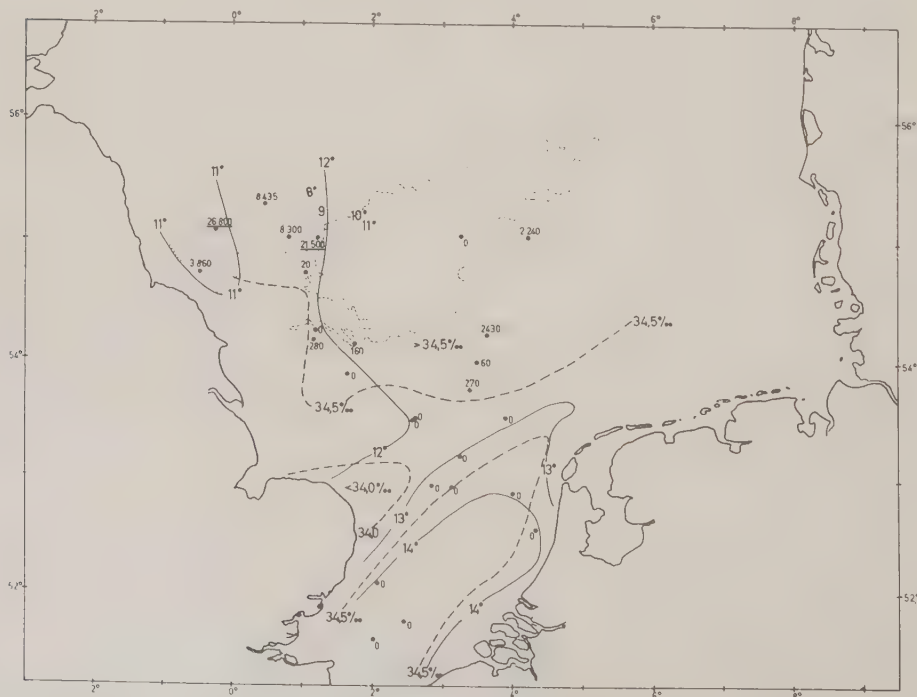


Figure 20. Number of haddock caught per 10 hours trawling by the F.R.S. "Anton Dohrn" in October 1956, together with isotherms for surface (continuous line) and bottom (dotted line), and surface isohalines (broken line).

Table 26. Mean catch per 10 hours trawling (number of fish) and age composition (%) of haddock caught by the F.R.S. "Anton Dohrn" in the North Sea in April 1956

| Age-group              | Year-class | German Bight<br>Dogger Bank | Great<br>Fisher Bank | Gut          | Fladen Ground |
|------------------------|------------|-----------------------------|----------------------|--------------|---------------|
| 0                      | 1956       | —                           | —                    | —            | —             |
| I                      | 1955       | 7 (60)                      | 6540 (97)            | 17,710 (88)  | 8160 (79)     |
| II                     | 1954       | 3 (24)                      | 120 (2)              | 1457 (7)     | 1495 (14.5)   |
| III                    | 1953       | 2 (16)                      | 20 (0.5)             | 540 (3)      | 305 (3)       |
| IV                     | 1952       | —                           | 20 (0.5)             | 249 (1.5)    | 280 (3)       |
| V                      | 1951       | —                           | —                    | 55 (0.5)     | 25 (0.5)      |
| All ages . . . . .     |            | 12 (100)                    | 6700 (100)           | 20,011 (100) | 10,265 (100)  |
| Trawl stations . . . . |            | 43                          | 1                    | 3            | 4             |

## Mean lengths (cm.)

|     |      | German Bight |       |             | Great Fisher Bank |       |             | Gut    |       |             | Fladen Ground |       |             |
|-----|------|--------------|-------|-------------|-------------------|-------|-------------|--------|-------|-------------|---------------|-------|-------------|
|     |      | Mean         | Range | No. of fish | Mean              | Range | No. of fish | Mean   | Range | No. of fish | Mean          | Range | No. of fish |
| 0   | 1956 | —            | —     | —           | —                 | —     | —           | —      | —     | —           | —             | —     | —           |
| I   | 1955 | 17.9         | 15—20 | 15          | 17.0              | 13—21 | 327         | 15.8   | 12—23 | 1048        | 16.3          | 11—22 | 850         |
| II  | 1954 | (29.2)       | 26—31 | 6           | (27.8)            | 27—30 | 6           | 27.4   | 24—33 | 48          | 26.4          | 21—32 | 222         |
| III | 1953 | (31.5)       | 28—36 | 4           | (32.0)            | —     | 1           | 31.0   | 28—39 | 24          | 31.6          | 24—41 | 51          |
| IV  | 1952 | —            | —     | —           | (44.0)            | —     | 1           | 36.4   | 30—42 | 11          | 36.1          | 30—50 | 52          |
| V   | 1951 | —            | —     | —           | —                 | —     | —           | (38.0) | 33—43 | 2           | (39.6)        | 35—49 | 5           |

part). The 1955 year-class was markedly predominant in all regions with the exception of that west of the Shetland Islands, where the older haddock were most numerous. Besides the 1955 brood, only the 1954 and 1953 year-classes were of importance.

Sampling in September and October indicated that the 1956 brood was not well represented and seems to be relatively small.

The mean lengths of haddock are shown in Tables 25—27 (lower part). From Table 25 it appears that the larger fish of all age-groups were caught in the north-eastern part of the North Sea, while the smaller haddock came from western areas. Peculiarities in the Svinøy area may perhaps be due to a mixture of different haddock populations.

## Haddock distribution and hydrographical conditions

The results obtained on two cruises of the "Anton Dohrn", one in the Dogger Bank area in September and the other in the southern North Sea in October, indicate a close relation between haddock distribution and hydrographical conditions (Figures 19 and 20). As shown in Figure 19, the isoline for a catch of 10,000 haddock per 10 hours trawling runs parallel to the isotherm of 13°C. over considerable distances. In areas with higher temperatures the density of haddock falls off quickly. Likewise an area north of the Dogger Bank with cold water (below 5°C.) seems to be avoided by haddock. In October (Figure 20) none of the numerous hauls made south of 53°30' N.

in waters of relatively high temperature and low salinity yielded any haddock. Catches of more than 10,000 haddocks per 10 hours trawling were only made west of the Dogger where bottom temperatures were below 11°C. and salinity over 34.5<sup>0</sup>/<sub>00</sub>.

Table 27. Mean catch per 10 hours trawling (number of fish) and age composition (%) of haddock caught by the F.R.S. "Anton Dohrn" in the North Sea in September/October 1956

| Age-group                | Year-class | German Bight | Central Area<br>(Gut, Dogger Bank) |
|--------------------------|------------|--------------|------------------------------------|
| 0 . . . . .              | 1956       | 4 (3)        | 7 (+)                              |
| I . . . . .              | 1955       | 140 (92)     | 10,556 (90)                        |
| II . . . . .             | 1954       | 8 (5)        | 903 (8)                            |
| III . . . . .            | 1953       | —            | 186 (2)                            |
| IV . . . . .             | 1952       | —            | 25 (+)                             |
| V . . . . .              | 1951       | —            | 1 (+)                              |
| VI . . . . .             | 1950       | —            | 0.5 (+)                            |
| All ages . . . . .       |            | 152 (100)    | 11,678 (100)                       |
| Trawl stations . . . . . |            | 5            | 45                                 |

## Mean lengths (cm.)

|               |      | German Bight |       |             | Central Area |       |             |
|---------------|------|--------------|-------|-------------|--------------|-------|-------------|
|               |      | Mean         | Range | No. of fish | Mean         | Range | No. of fish |
| 0 . . . . .   | 1956 | (19.0)       | —     | 1           | (14.8)       | 14—19 | 6           |
| I . . . . .   | 1955 | 24.5         | 22—29 | 35          | 24.4         | 18—34 | 5896        |
| II . . . . .  | 1954 | 34.0         | 33—35 | 2           | 34.0         | 27—45 | 1075        |
| III . . . . . | 1953 | —            | —     | —           | 38.4         | 30—52 | 306         |
| IV . . . . .  | 1952 | —            | —     | —           | 42.3         | 34—51 | 35          |
| V . . . . .   | 1951 | —            | —     | —           | (56.3)       | 54—72 | 3           |
| VI . . . . .  | 1950 | —            | —     | —           | (60.0)       | —     | 1           |

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Table 28. Landings of haddock by British steam trawlers from the North Sea in 1954-1956

| 1954<br>Quarterly<br>period | North of 57°30'N.             |                                                |                               | 55°N. to 57°30'N.                              |                               |                                                | South of 55°00'N.             |                                                |                               | All areas                                      |                               |                                                |
|-----------------------------|-------------------------------|------------------------------------------------|-------------------------------|------------------------------------------------|-------------------------------|------------------------------------------------|-------------------------------|------------------------------------------------|-------------------------------|------------------------------------------------|-------------------------------|------------------------------------------------|
|                             | Weight<br>landed/<br>100 cwt. | Weight<br>100 hrs. landed/<br>fishing 100 hrs. | Weight<br>landed/<br>100 cwt. | Weight<br>100 hrs. landed/<br>fishing 100 hrs. | Weight<br>landed/<br>100 cwt. | Weight<br>100 hrs. landed/<br>fishing 100 hrs. | Weight<br>landed/<br>100 cwt. | Weight<br>100 hrs. landed/<br>fishing 100 hrs. | Weight<br>landed/<br>100 cwt. | Weight<br>100 hrs. landed/<br>fishing 100 hrs. | Weight<br>landed/<br>100 cwt. | Weight<br>100 hrs. landed/<br>fishing 100 hrs. |
| Jan.-Mar.                   | 554                           | 528                                            | 105                           | 131                                            | 295                           | 44                                             | 21                            | 1366                                           | 2                             | 707                                            | 2188                          | 32                                             |
| Apr.-June                   | 635                           | 583                                            | 109                           | 260                                            | 706                           | 37                                             | 50                            | 834                                            | 2                             | 945                                            | 2123                          | 45                                             |
| July-Sept.                  | 617                           | 443                                            | 139                           | 637                                            | 826                           | 77                                             | 160                           | 729                                            | 22                            | 1414                                           | 1997                          | 71                                             |
| Oct.-Dec.                   | 699                           | 461                                            | 152                           | 821                                            | 712                           | 115                                            | 129                           | 917                                            | 14                            | 1649                                           | 2091                          | 79                                             |
| Year                        | 2505                          | 2015                                           | 124                           | 1849                                           | 2539                          | 73                                             | 360                           | 3846                                           | 9                             | 4715                                           | 8399                          | 56                                             |
| 1955                        |                               |                                                |                               |                                                |                               |                                                |                               |                                                |                               |                                                |                               |                                                |
| Jan.-Mar.                   | 849                           | 542                                            | 157                           | 148                                            | 346                           | 43                                             | 10                            | 1043                                           | 1                             | 1007                                           | 1931                          | 52                                             |
| Apr.-June                   | 829                           | 483                                            | 172                           | 234                                            | 654                           | 36                                             | 25                            | 675                                            | 4                             | 1088                                           | 1812                          | 60                                             |
| July-Sept.                  | 725                           | 438                                            | 166                           | 542                                            | 628                           | 86                                             | 97                            | 577                                            | 17                            | 1364                                           | 1644                          | 83                                             |
| Oct.-Dec.                   | 928                           | 572                                            | 162                           | 468                                            | 432                           | 108                                            | 109                           | 786                                            | 14                            | 1505                                           | 1790                          | 84                                             |
| Year                        | 3331                          | 2035                                           | 164                           | 1392                                           | 2060                          | 68                                             | 241                           | 3081                                           | 8                             | 4964                                           | 7177                          | 69                                             |
| 1956                        |                               |                                                |                               |                                                |                               |                                                |                               |                                                |                               |                                                |                               |                                                |
| Jan.-Mar.                   | 707                           | 474                                            | 149                           | 138                                            | 314                           | 44                                             | 8                             | 803                                            | 1                             | 853                                            | 1592                          | 54                                             |
| Apr.-June                   | 874                           | 448                                            | 195                           | 268                                            | 586                           | 46                                             | 23                            | 492                                            | 5                             | 1165                                           | 1525                          | 76                                             |
| July-Sept.                  | 523                           | 420                                            | 125                           | 573                                            | 582                           | 98                                             | 91                            | 530                                            | 17                            | 1186                                           | 1532                          | 77                                             |
| Oct.-Dec.                   | 838                           | 461                                            | 182                           | 432                                            | 391                           | 110                                            | 130                           | 679                                            | 19                            | 1400                                           | 1532                          | 91                                             |
| Year                        | 2942                          | 1803                                           | 163                           | 1411                                           | 1873                          | 75                                             | 252                           | 2504                                           | 10                            | 4604                                           | 6181                          | 74                                             |

### British Statistics

The data in Table 28 are presented as a summary of the landings by British steam trawlers from

1954 onwards. For earlier years see Ann. Biol., X (1953).

R. JONES, W. MAIN

## SAITHE

### Iceland Stock

### Remarks on the Young Saithe off the North Coast of Iceland in 1956

(Figure 21)

During August 1956 some pelagic catches of saithe were made off the north coast of Iceland. The total yield amounted to about 25,000 hl. and the catch went to the factories for oil and meal production. Two samples originating from the middle of the north coast were examined on 9. August.

The size distribution, which was rather alike in both samples, is as follows:—

| cm.   | Number of fish | %    |
|-------|----------------|------|
| 75-79 | 9              | 8    |
| 70-74 | 55             | 47   |
| 65-69 | 355            | 305  |
| 60-64 | 555            | 475  |
| 55-59 | 123            | 106  |
| 50-54 | 23             | 20   |
| 45-49 | 30             | 26   |
| 40-44 | 6              | 5    |
| 35-39 | 9              | 8    |
| Total | 1165           | 1000 |

M. length: 62.84 cm.

It appears that nearly 90% of the fish caught ranged between 55 and 70 cm.

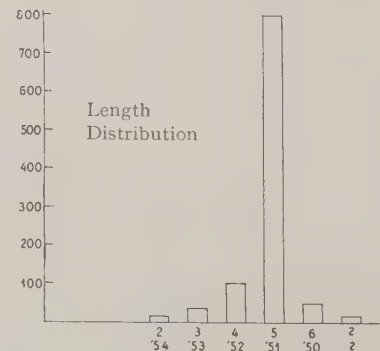


Figure 21.



A survey of the age composition and the size by age is presented by the following figures. The 5-year-old fish predominated, making up four-fifths of the catches (1951 year-class).

| Age         | Brood | Number | ‰    | Average length |
|-------------|-------|--------|------|----------------|
| 2 .....     | 1954  | 2      | 13   | 36.00          |
| 3 .....     | 1953  | 5      | 33   | 49.60          |
| 4 .....     | 1952  | 15     | 99   | 57.40          |
| 5 .....     | 1951  | 120    | 795  | 64.26          |
| 6 .....     | 1950  | 7      | 47   | 70.29          |
| ? .....     | ?     | 2      | 13   | —              |
| Total ..... |       | 151    | 1000 | 62.92          |

Young saithe have been caught pelagically off the north coast of Iceland in 1950, 1951, 1952, 1953, and 1954 (see Ann. Biol. for these years, pp. 42, 43, 42, and 103).

Á. FRÍÐRIKSSON

### German Commercial Landings

(Tables 29–34)

The market landings by German trawlers of saithe from Icelandic waters in 1956 rose for the first time since 1951/52 (see Table 29). This, however, applies only to market categories II and III (medium and small); the landings of large fish of category I remained low, at almost the same level as in 1955, at about one-third of the yield in the best year, 1951.

Table 30 shows the main features of the length frequency distribution and age composition from German landings in 1956, for various fishing grounds. The figures are based on the age determinations of 15,727 saithe caught by German trawlers during the period January to December 1956.

Table 29. Commercial landings of saithe from Icelandic waters by German trawlers (in tons)

|                                               | 1950   | 1951   | 1952   | 1953   | 1954   | 1955   | 1956 <sup>1)</sup> |
|-----------------------------------------------|--------|--------|--------|--------|--------|--------|--------------------|
| Size category I (large) .....                 | 22,825 | 24,860 | 22,632 | 16,019 | 12,586 | 7,362  | 7,835              |
| Size category II+III (medium and small) ..... | 7,010  | 8,759  | 12,692 | 7,422  | 11,834 | 8,982  | 14,173             |
| Total .....                                   | 29,835 | 33,439 | 35,324 | 23,441 | 24,420 | 16,344 | 22,008             |

<sup>1)</sup> provisional figures.

Table 30. Length and age composition of the German landings of saithe in 1956 from Icelandic waters (‰)

| cm.                      | North-west coast        | South and south-west coast | South-east coast       | All areas               | Year-classes           | North-west coast | South and south-west coast | South-east coast | All areas |
|--------------------------|-------------------------|----------------------------|------------------------|-------------------------|------------------------|------------------|----------------------------|------------------|-----------|
| 41—45....                | 2                       | —                          | +                      | 1                       | 1953.....              | 3                | —                          | —                | 1         |
| 46—50....                | 14                      | 2                          | 8                      | 11                      | 1952.....              | 60               | 3                          | 18               | 42        |
| 51—55....                | 73                      | 8                          | 37                     | 57                      | 1951.....              | 306              | 46                         | 101              | 223       |
| 56—60....                | 148                     | 17                         | 80                     | 114                     | 1950.....              | 365              | 161                        | 305              | 322       |
| 61—65....                | 186                     | 36                         | 103                    | 147                     | 1949.....              | 159              | 276                        | 307              | 205       |
| 66—70....                | 199                     | 76                         | 143                    | 168                     | 1948.....              | 50               | 205                        | 100              | 86        |
| 71—75....                | 147                     | 129                        | 177                    | 148                     | 1947.....              | 10               | 47                         | 30               | 20        |
| 76—80....                | 90                      | 144                        | 128                    | 105                     | 1946.....              | 9                | 45                         | 28               | 18        |
| 81—85....                | 49                      | 160                        | 81                     | 73                      | 1945.....              | 8                | 59                         | 31               | 21        |
| 86—90....                | 32                      | 122                        | 72                     | 55                      | 1944.....              | 5                | 25                         | 26               | 12        |
| 91—95....                | 15                      | 79                         | 62                     | 34                      | 1943.....              | 3                | 15                         | 12               | 7         |
| 96—100....               | 12                      | 91                         | 49                     | 32                      | 1942.....              | 2                | 14                         | 9                | 5         |
| 101—105....              | 13                      | 60                         | 37                     | 25                      | 1941.....              | 3                | 19                         | 6                | 6         |
| 106—110....              | 14                      | 53                         | 17                     | 21                      | 1940.....              | 3                | 19                         | 5                | 6         |
| 111—115....              | 5                       | 20                         | 5                      | 8                       | 1939.....              | 9                | 30                         | 12               | 13        |
| 116—120....              | 1                       | 3                          | 1                      | 1                       | 1938.....              | 1                | 7                          | 2                | 2         |
| 121—125....              | +                       | —                          | —                      | +                       | 1937.....              | 3                | 17                         | 5                | 6         |
|                          |                         |                            |                        |                         | 1936.....              | +                | 6                          | 1                | 2         |
|                          |                         |                            |                        |                         | 1935.....              | 1                | 4                          | 1                | 2         |
| Total number of fish kg. | 4,247,729<br>12,398,055 | 1,186,650<br>5,553,376     | 1,142,204<br>4,056,375 | 6,666,428<br>22,007,806 | 1934.....<br>1933..... | +                | 2<br>—                     | 1<br>+           | 1<br>+    |

Mean catch per day's fishing (all Icelandic fishing areas)

| Fishing season .... | 1946/47 | 47/48 | 48/49 | 49/50 | 50/51 | 51/52 | 52/53 | 53/54 | 54/55 | 55/56 | 56/57 <sup>1)</sup> |
|---------------------|---------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------------------|
| May to April        |         |       |       |       |       |       |       |       |       |       |                     |
| Number of fish ...  | 1728    | 1437  | 1050  | 748   | 914   | 785   | 629   | 485   | 702   | 730   | 1168                |
| Kilogrammes .....   | 7290    | 5230  | 4425  | 3200  | 3750  | 3917  | 2975  | 2100  | 2358  | 2417  | 3568                |

<sup>1)</sup> provisional figures.

Table 31. Length and age composition of the spawning stock of saithe in the main spawning period, January to April (‰)

| cm.          | 1953 | 1954 | 1955 | 1956 | Year-classes        | 1953 | 1954 | 1955 | 1956 |
|--------------|------|------|------|------|---------------------|------|------|------|------|
| 46—50.....   | +    | +    | +    | 2    | 1952.....           | —    | —    | —    | 1    |
| 51—55.....   | 1    | 3    | 7    | 10   | 1951.....           | —    | —    | —    | 19   |
| 56—60.....   | 1    | 11   | 20   | 16   | 1950.....           | —    | —    | 19   | 85   |
| 61—65.....   | 1    | 25   | 56   | 31   | 1949.....           | —    | 16   | 102  | 275  |
| 66—70.....   | 10   | 54   | 44   | 52   | 1948.....           | 2    | 96   | 231  | 247  |
| 71—75.....   | 42   | 50   | 82   | 100  | 1947.....           | 22   | 96   | 75   | 58   |
| 76—80.....   | 98   | 79   | 110  | 131  | 1946.....           | 131  | 196  | 82   | 57   |
| 81—85.....   | 188  | 122  | 79   | 166  | 1945.....           | 150  | 84   | 81   | 70   |
| 86—90.....   | 180  | 147  | 76   | 135  | 1944.....           | 249  | 158  | 62   | 26   |
| 91—95.....   | 130  | 143  | 98   | 89   | 1943.....           | 85   | 38   | 26   | 15   |
| 96—100.....  | 95   | 105  | 116  | 103  | 1942.....           | 25   | 16   | 20   | 16   |
| 101—105..... | 134  | 101  | 123  | 65   | 1941.....           | 26   | 20   | 36   | 26   |
| 106—110..... | 80   | 107  | 130  | 68   | 1940.....           | 38   | 21   | 24   | 25   |
| 111—115..... | 39   | 43   | 50   | 28   | 1939.....           | 69   | 68   | 88   | 35   |
| 116—120..... | 1    | 9    | 9    | 4    | 1938.....           | 20   | 17   | 15   | 9    |
| 121—125..... | —    | 1    | +    | —    | 1937.....           | 40   | 44   | 60   | 22   |
|              |      |      |      |      | 1936.....           | 36   | 14   | 14   | 8    |
|              |      |      |      |      | 1935.....           | 39   | 58   | 48   | 6    |
|              |      |      |      |      | 1934.....           | 32   | 19   | 5    | 3    |
|              |      |      |      |      | 1933 and older .... | 27   | 39   | 12   | —    |

In the north-western area, which provided more than half the total annual catch of saithe, young fish of the 1949-51 year-classes form the greatest proportion of the fish between 56 and 75 cm. in length. The 1950 and 1951 year-classes are by far the most numerous, and amount to about two-thirds of the landings from the north-western area. The strength of these two year-classes promises a more plentiful stock in the future than in recent years. The numbers of the larger and older fish from the 1947 year-class and upwards are insignificant.

The bulk of the fish caught off the south and south-west coasts, where the main spawning grounds lie are between 75 and 90 cm. in length. The year-classes present are those from 1950 to 1948 with the 1949 year-class predominant. The large, old fish, especially those of the 1944-46, 1939, and 1937 year-classes, are represented on a larger scale than in the north-western area but there are on the whole surprisingly few of them.

The length and age compositions of the fish caught off the south-east coast are intermediate between those of the north-western and south-western coasts. The 1950 and 1949 year-classes predominate.

In general, we notice that the 1951-49 year-classes, with a length range of 60-80 cm., in all areas predominate distinctly; fish of these groups are concentrated chiefly on the grounds north-west of Iceland. All the other year-classes, especially those of 1944-46 and 1939, 1937, and 1935, which were formerly important, have become insignificant in numbers. Consequently, the average length and age of the fish caught are very low. Thanks to the abundance of new recruits,

the mean catch per day's fishing—the measure of population density—increased in 1956.

As regards age composition, it is well known that in the last 10 years there have been three occasions on which recruitment to the stock has been sufficient to influence the yield of the fishery. The strong 1939, 1937, and 1935 year-classes produced an unusually plentiful stock, which lasted until 1949/50. Then, in 1950/51, a new wave of recruits came in, in the form of the 1944-46 year-classes. The effect of this was soon dissipated however, because these year-classes were not as strong as the old 1939-35 year-classes and could not entirely replace them when they disappeared; the 1945 year-class in particular failed to redeem its original promise as a good year-class. The mean catch per day's fishing gradually fell off. The third wave of recruits, the 1951-49 year-classes, again caused a slow increase in the mean catch per day's fishing, especially in 1956.

In association with the increase in the density and abundance of the population, the growth-rate of the young year-classes diminished, particularly on the north-western fishing grounds. As was to be expected we found an increase in the growth-rate of the older year-classes:—

| Mean length (cm.) of age-groups (all areas) |         |       |       |  |
|---------------------------------------------|---------|-------|-------|--|
|                                             | VI—VIII | IX—XV | XV+   |  |
| 1952/53 .....                               | 79.9    | 98.2  | 107.3 |  |
| 1953/54 .....                               | 84.2    | 97.7  | 108.4 |  |
| 1954/55 .....                               | 81.1    | 98.9  | 108.8 |  |
| 1955/56 .....                               | 80.2    | 99.5  | 109.3 |  |
| 1956/57 .....                               | 78.3    | 100.5 | 109.9 |  |

Since 1953/54, when the population was least dense, the mean length of the VI-VIII age-groups has fallen from 84.2 to 78.3 cm., that of the IX to

Table 32. Landings of saithe (1000 kg.) and mean catch per day's fishing off the south-west and south coasts of Iceland in the main spawning period 1950—1956

|           | Saithe landings<br>January to April | Mean catch per day's<br>fishing (March)<br>kg. | No. of fish |
|-----------|-------------------------------------|------------------------------------------------|-------------|
| 1950..... | 14,985                              | 7,600                                          | 1,485       |
| 1951..... | 19,205                              | 7,100                                          | 1,553       |
| 1952..... | 16,514                              | 5,200                                          | 1,168       |
| 1953..... | 6,536                               | 5,200                                          | 1,028       |
| 1954..... | 5,054                               | 4,700                                          | 915         |
| 1955..... | 3,396                               | 3,950                                          | 770         |
| 1956..... | 3,766                               | 3,809                                          | 756         |

XV age-groups has risen from 97.7 to 100.5; for fish older than 16 years, the increase is 108.4 to 109.9 cm.

Despite the growth of knowledge of the biology of the saithe, we have only just begun to grapple with many of the most important problems, such as the relation of various environmental factors to the yield of the fishery and the evaluation of these effects in connexion with migration and the "availability" of saithe schools to fishing.

There is, for instance the question of the surprisingly small proportion of the 1939—35 year-classes in the landings; the absence of these groups from the stock on the spawning grounds off the south-west coast during the spawning period is very pronounced, as Table 31 shows. Examination of length and age compositions in recent years make the disappearance of older year-classes hard to understand. In addition to the normal fluctuations in year-class strength, there seem to be other factors which affect the yield of the fishery.

In contrast with conditions in the north-western area the third wave of recruits joining the spawning stock off the south-west coast had only little effect on population density and the yield of the fishery, because the 1950 and 1951 year-classes had already become mature to some extent. Indeed, although the 1949 and 1948 year-classes are by far the most numerous they have not been able to make up for the surprising disappearance of the older fish, especially the rich 1939, 1937, and 1935 year-classes. The mean catch per day's fishing is accordingly small, as Table 32 shows.

Table 33. Age and length compositions of saithe caught off the Faroes in December 1956 and January 1957 (<sup>0</sup>/<sub>100</sub>)

| cm.     | Dec. 1956 | Jan. 1957 | Year-classes | Dec. 1956 |
|---------|-----------|-----------|--------------|-----------|
| 60—65   | 4         | —         | 1951         | 11        |
| 66—70   | 5         | 1         | 1950         | 36        |
| 71—75   | 18        | 5         | 1949         | 139       |
| 76—80   | 40        | 28        | 1948         | 87        |
| 81—85   | 94        | 57        | 1947         | 92        |
| 86—90   | 138       | 81        | 1946         | 119       |
| 91—95   | 164       | 116       | 1945         | 106       |
| 96—100  | 188       | 196       | 1944         | 60        |
| 101—105 | 183       | 249       | 1943         | 51        |
| 106—110 | 123       | 186       | 1942         | 44        |
| 111—115 | 36        | 71        | 1941         | 83        |
| 116—120 | 4         | 10        | 1940         | 30        |
| 121—125 | 3         | +         | 1939         | 70        |
|         |           |           | 1938         | 20        |
|         |           |           | 1937         | 37        |
|         |           |           | 1936         | 8         |
|         |           |           | 1935         | 6         |
|         |           |           | 1934         | 1         |

It has already been pointed out that the decrease in density and numbers is not so great as to account entirely for the sharp decline in landings. The principal reason is probably the change-over from saithe to redfish in the first four months of the year. In 1950—52 from a half to two-thirds of the total yearly landings of saithe were from the spawning grounds, but during the last three years the catch from these grounds amounted only to 14—17% of the total. The saithe fishery in summer is now centred on the north-western fishing grounds, where the juvenile year-classes are concentrated. Consequently, a fall in the yield of the large, old fish of market category I must be expected, but not so sharp as we in fact found it.

There is something strange about the fact that the disappearance of the large, old fish from the spawning grounds south-west of Iceland coincides with the appearance of unusually large quantities of old fish in the vicinity of the Faroes. In December 1956 and also in January 1957 a new fishing ground north-east of the Faroes yielded more than 7 million kilogrammes of saithe, of which nearly all belonged to market category I. The figures relating to these landings are given in Table 33.

The predominant lengths are from 86 to 115 cm., with a peak at 96 to 105 cm.; this is even more

Table 34. Growth-rate (cm.) of Faroese and Icelandic saithe (mean lengths Oct./Dec. 1952—56)

|                          | Age-groups |      |      |      |      |      |      |      |      |       |       |       |       |       |       |       |       |  |  |
|--------------------------|------------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|--|--|
|                          | III        | IV   | V    | VI   | VII  | VIII | IX   | X    | XI   | XII   | XIII  | XIV   | XV    | XVI   | XVII  | XVIII | XIX   |  |  |
| Farbes (after BERTELSEN) | 38.6       | 48.8 | 60.2 | 71.8 | 78.4 | 82.6 | 84.2 | 91.3 | —    | —     | —     | —     | —     | —     | —     | —     | —     |  |  |
| Faroes, Dec. 1956        | —          | —    | 69.6 | 76.9 | 83.8 | 88.8 | 92.4 | 95.3 | 98.0 | 100.7 | 102.1 | 103.2 | 104.9 | 106.4 | 107.1 | 108.7 | 109.7 |  |  |
| S.W. Iceland             | —          | 57.3 | 67.4 | 75.8 | 83.1 | 89.0 | 92.7 | 95.9 | 98.3 | 100.2 | 102.1 | 103.4 | 104.8 | 106.4 | 107.3 | 108.7 | 109.6 |  |  |



distinct in January 1957. As regards age composition, the 1949 year-class is predominant, but the 1946 and 1945 year-classes are nearly as numerous and the old 1939 and 1937 year-classes are also present in fairly large numbers. It seems as if the majority of these fish do not normally inhabit Faroe waters but have immigrated from other grounds, the more so as they disappeared entirely in February 1957. The discovery of these new fishing grounds is not so very astonishing for it is well known that Faroese waters possess their own stock of saithe but the growth-rate of Faroese fish differs from that of the Icelandic.

According to BERTELSEN's excellent survey of the saithe of the Faroes, the growth of the Faroese saithe is intermediate between that of the Norwegian and the Icelandic. But the mean lengths of the saithe of different ages caught in December 1956 in Faroese waters are quite different from those reported by BERTELSEN, whereas they agree quite well with those for Icelandic waters. There are thus only two interpretations of these phenomena:—

- (1) the growth-rate of the Faroese stock must have increased remarkably, or
- (2) the saithe caught in December 1956 did not belong to the Faroese stock but were temporary immigrants.

There are certain features which caused us to suspect the possibility of immigration:—the resemblance of the growth-rate to that of the Icelandic saithe, in connexion with the similarity in type of otolith, and the perplexing decrease in the numbers of older fish on the Icelandic spawning grounds together with the sudden appearance of old fish in large quantities at the Faroes.

It seems that the will to migrate in older fish is much stronger than was thought, and the more closely our data are examined the more we appreciate the fact that investigations on population size alone are not sufficient to indicate the varied course of a fishery, or to lead to an understanding of the dynamics of the saithe stocks. In consequence of the semi-pelagic behaviour of the saithe and its diurnal rhythm, its relative low sensibility to changes in temperature and salinity, and the irregularity in its migratory habits and so on, it is extraordinarily difficult to obtain the data required to solve the problems of the relationship of environment to reproduction and survival, and to enable one to predict the abundance of the saithe population.

ULRICH SCHMIDT

## Arcto-Norwegian Stock

### Soviet Investigations

(Figures 22–25; Table 35)

The Polar Institute undertakes regular studies of the composition of the catches of reconnaissance trawlers in different regions of the sea. This includes not only measuring and dissecting the fish, to obtain otolith samples for age determination, but in many cases records are made of the species composing the catch; thus data are obtained on fish which are not as a rule fished by trawlers. In this way a considerable amount of information has been collected about the saithe, including both the number of fish caught and their size. These data have been analysed and plotted on charts by N. V. MIRONOVA (Murmansk Biological Station of the U.S.S.R. Academy of Sciences).

In addition, N.V. MIRONOVA has summarized the records of catches taken with a young-fish seine in certain inlets of the east Murman coast in 1949–1955. These data provide information on the relative numbers of cod and saithe fry in the inlets, on their size, and also on the times of mass approach to the shore during the period. In N.V. MIRONOVA's work the data on the trawl catches of saithe are plotted separately for each month. Four charts are reproduced here, which summarize the data by seasons, January–March, April–June, July–September, and October–December (Figures 22–25).

The first of these charts applies to the spawning season of the saithe. At this time large mature fish concentrate on the north-western coast of Norway. These occur there with shoals of smaller fish, large aggregations which may be encountered off Kola Bay and the Rybachii Peninsula, and small shoals occur off the Finnmark and eastern Murman coasts. The very largest fish, indicated by black circles, keep mostly to the north-east of Andey Bank.

The size of the circles in the charts indicates the number of fish in the catches; small circles show from 1 to 10 fish per haul, medium circles from 10 to 100, and large circles more than 100. Black indicates the largest fish, more than 100 cm. long; cross-hatching indicates large, mainly mature fish from 60 to 100 cm. long; vertical hatching indicates medium-sized fish from 30 to 60 cm. long; and white circles indicate young fish up to 30 cm. long.

The second chart shows that the large mature fish move eastward after spawning in the direction of the North Cape Current and are found in relatively large quantities off the Rybachii Peninsula at





Figure 22. Distribution of saithe: size-groups in January-March.

Diameter of circles:  
1. More than 100 fish per haul.  
2. 10—100 fish per haul.  
3. 1—10 fish per haul.

Shading:  
4. Fish over 100 cm. long.  
5. Fish 60—100 cm.  
6. Fish 30—60 cm.  
7. Fish up to 30 cm. long.

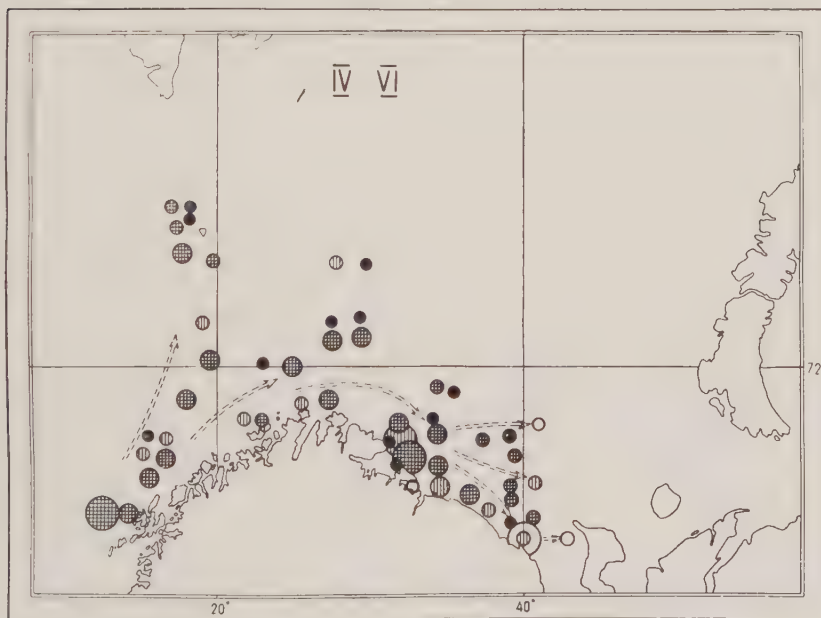


Figure 23. Distribution of saithe in April—June.  
For symbols, see Figure 22.

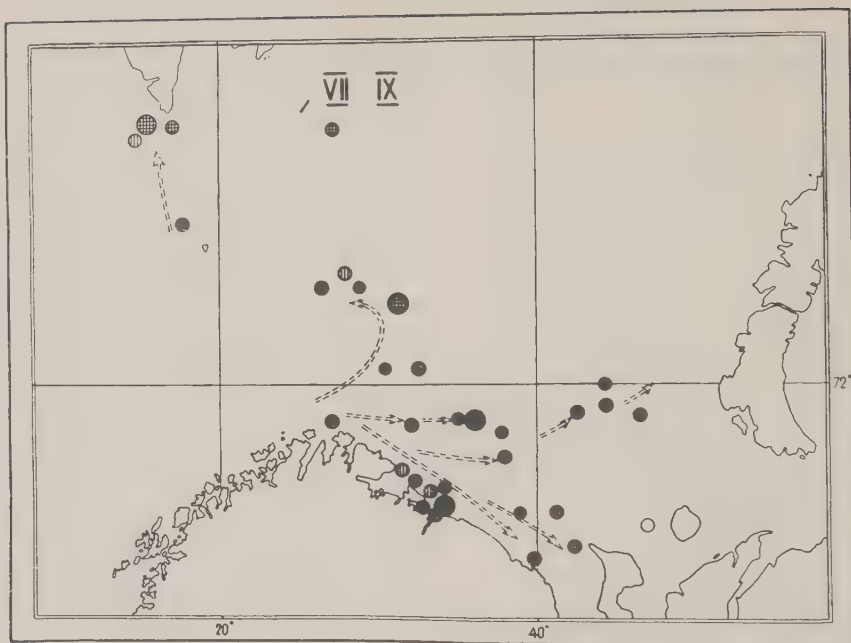


Figure 24. Distribution of saithe in July–September.  
For symbols, see Figure 22.

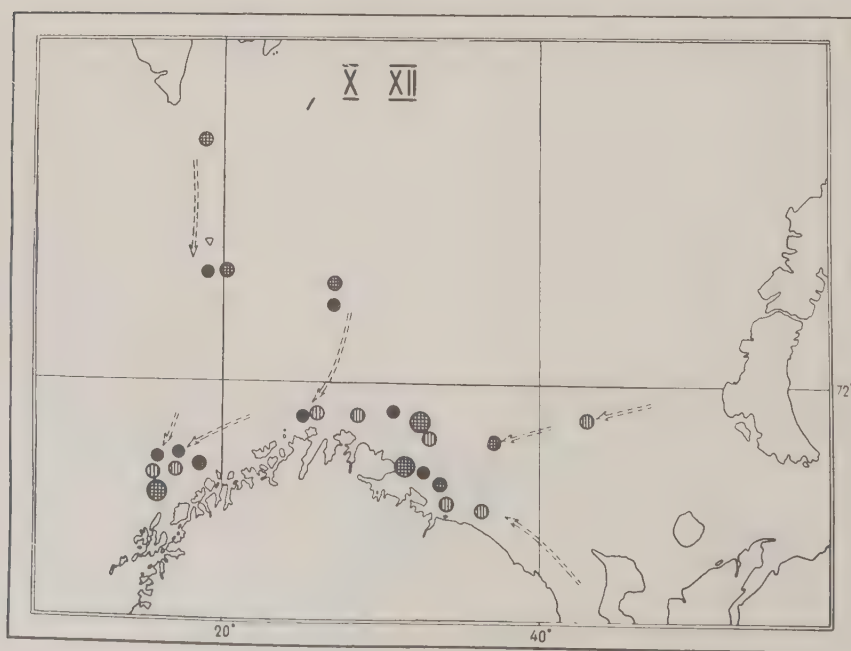


Figure 25. Distribution of saithe in October–December.  
For symbols, see Figure 22.

Table 35. Quantities of saithe and cod fry in catches taken with young-fish seine in certain inlets on the Murman coast in different years

| Year       | Number of fry caught |       |        | Percentage of cod and saithe fry |      |       | Number of hauls | Number of fry per haul |       |
|------------|----------------------|-------|--------|----------------------------------|------|-------|-----------------|------------------------|-------|
|            | Saithe               | Cod   | Total  | Saithe                           | Cod  | Total |                 | Saithe                 | Cod   |
| 1949 ..... | 4,537                | 63    | 4,600  | 98.5                             | 1.5  | 100   | 52              | 87.2                   | 1.2   |
| 1950 ..... | 55                   | 505   | 560    | 9.8                              | 90.2 | 100   | 85              | 0.6                    | 5.9   |
| 1951 ..... | 12,130               | 1,311 | 13,441 | 90.2                             | 9.8  | 100   | 56              | 216.6                  | 23.4  |
| 1952 ..... | 14,732               | 622   | 15,354 | 95.9                             | 4.1  | 100   | 38              | 387.6                  | 16.3  |
| 1953 ..... | 9,126                | 5,599 | 14,725 | 62.0                             | 38.0 | 100   | 23              | 396.7                  | 243.4 |
| 1954 ..... | 7,732                | 430   | 3,162  | 94.7                             | 5.3  | 100   | 19              | 406.9                  | 22.6  |
| 1955 ..... | 4,072                | 194   | 4,266  | 95.5                             | 4.5  | 100   | 20              | 203.6                  | 9.7   |

Varanger, as well as off Finnmark, and begin to appear in hauls as far eastwards as 40°E. Medium-sized saithe occur in relatively large quantities off the Varanger Peninsula; small saithe occur off Svyatoi Nos and in small quantities at Cape Kanin. Some of the fish move with the Spitsbergen Current and at this time of the year travel as far northward as 75°N.

The third chart summarizes the data for June–September. At this season the large saithe in the central regions travel as far as 46°E.; on the Murman coast they are caught off the Kola Bay, and in Motovsky Bay. A few fish may be taken in a haul in many places to the east and south-east as far as the Kanin Peninsula; the smallest fish were caught to the west of Kolguev Island.

In the north-west, catches of up to 100 large saithe were recorded from south-west of West Spitsbergen, and in smaller numbers from south of South Cape and south-east of Hope Island. Saithe of different sizes are widely distributed in the western regions, and extend almost up to 74°N. In these months the area covered by feeding saithe reaches its greatest extent.

The fourth chart, for October–December, clearly shows the westward movement of saithe in the southern part of the sea, and the southward movement in the north-western part of the sea. Large mature fish begin to gather near the Varanger Peninsula and near Lofoten. Naturally, as Soviet trawlers do not fish specially for saithe, the data obtained in this way are not quite comparable with those obtained by German ships, for instance, which fish for saithe on a commercial scale off the coasts of Norway. Nevertheless, our data serves a useful purpose in presenting a general picture of the saithe distribution in the Barents Sea, together with a rough idea of its migrations.

Table 35 shows the number of saithe and cod fry caught in the Dalne-Zelenetsky Inlet and adjacent sectors of the east Murman coast. Only in 1950 were more cod fry caught than saithe fry. As a rule the number of saithe was considerable, much greater than the number of cod. In columns 4 and 5 the figures given are percentages of the total fry caught in a year. In 5 cases out of 7 the number of saithe was more than 90% and in one case it was 62%. Columns 8 and 9 give the estimated number of fry of both species per haul for each year.

Certain conclusions may now be drawn. The first is that on the basis of such catches it is impossible to judge the relative strengths of the various year-classes of cod, as is evident from a comparison with the data given in the first section of this report (see p.143). The highest number given here is that for 1953, while in 1950 the total quantity and the number caught per haul are less than for any year except 1949 (only with respect to the total), 1954, and 1955.

Examination of the figures for saithe caught by German trawlers (U. SCHMIDT) shows that it is impossible to estimate year-class strength for this fish also by this method.

Although these data cover only the catches of fry in a limited section of the Murman coast, data were obtained many years ago for other inlets of the Murman coast, and these indicate that the number of saithe fry in a catch can considerably exceed the number of cod fry. It is also known that fry and juvenile stages of haddock occur only in very limited numbers in the inlets during their first year of life, whereas by the spring of the second year they approach the coast in large numbers.

N. MASLOV

## German Landings

(Tables 36-37)

Table 36 shows the commercial landings of saithe caught off the Norwegian coast by German trawlers for the fishing seasons 1950-51 to 1955-1956. The season lasts usually from April to March; the figures for the Lofoten banks and the Svinøy area are shown separately. The total landings exhibit great variations, which are not the same for the two areas. These are caused partly by fluctuations in brood strength partly by other factors, as be described below. The increase in total landings in the last two seasons is due exclusively to the increased catches on the Lofoten banks.

Table 37 shows for each fishing season from 1950-51 to 1955-56 the length and age distributions of the spawning saithe caught by German trawlers at Svinøy in January/March together with the length and age compositions of the catches from the Lofoten banks. The figures for 1956 are based on the age determinations of 13,004 saithe.

At Svinøy in 1956, the 1948 year-class was replaced in the catches of spawning saithe by the 1949 year-class, which is by far the most predominant. The young 1950 year-class was also present in fairly large numbers, though the majority had not attained maturity. As a result of their strength, these year-classes were able to compensate to some extent for the decrease of the older

Table 37. Length frequencies and age composition of the spawning saithe at Svinøy, 1951 to 1956, and on the Lofoten banks, 1950-51 to 1955-56 (‰)

| cm.     | Spawning stock at Svinøy |      |      |      |      |      | Lofoten banks |       |       |       |       |       | Apr./Dec.          |
|---------|--------------------------|------|------|------|------|------|---------------|-------|-------|-------|-------|-------|--------------------|
|         | 1951                     | 1952 | 1953 | 1954 | 1955 | 1956 | 1950/51       | 51/52 | 52/53 | 53/54 | 54/55 | 55/56 | 1956 <sup>1)</sup> |
| 36-40   | —                        | —    | —    | —    | —    | —    | +             | +     | +     | +     | —     | +     | +                  |
| 41-45   | —                        | —    | —    | —    | —    | +    | 2             | 2     | 14    | 4     | 2     | 16    | 12                 |
| 46-50   | —                        | —    | —    | —    | +    | 8    | 24            | 28    | 75    | 75    | 27    | 75    | 83                 |
| 51-55   | —                        | +    | —    | —    | 1    | 19   | 45            | 94    | 112   | 72    | 128   | 187   | 145                |
| 56-60   | 6                        | 5    | 7    | +    | 7    | 40   | 96            | 194   | 159   | 159   | 280   | 237   | 187                |
| 61-65   | 21                       | 22   | 21   | 26   | 31   | 75   | 218           | 211   | 183   | 174   | 195   | 214   | 208                |
| 66-70   | 112                      | 78   | 118  | 111  | 88   | 176  | 237           | 179   | 146   | 189   | 124   | 125   | 161                |
| 71-75   | 256                      | 206  | 249  | 182  | 166  | 241  | 135           | 125   | 90    | 118   | 74    | 42    | 86                 |
| 76-80   | 174                      | 296  | 187  | 224  | 229  | 160  | 84            | 67    | 80    | 72    | 55    | 34    | 35                 |
| 81-85   | 170                      | 142  | 135  | 122  | 187  | 103  | 53            | 44    | 48    | 49    | 34    | 24    | 27                 |
| 86-90   | 88                       | 83   | 106  | 97   | 126  | 70   | 46            | 26    | 34    | 41    | 28    | 19    | 23                 |
| 91-95   | 85                       | 71   | 72   | 95   | 74   | 36   | 35            | 16    | 29    | 26    | 28    | 16    | 18                 |
| 96-100  | 53                       | 53   | 55   | 77   | 53   | 35   | 16            | 11    | 19    | 13    | 16    | 8     | 10                 |
| 101-105 | 20                       | 30   | 39   | 42   | 25   | 22   | 5             | 3     | 8     | 3     | 8     | 3     | 4                  |
| 106-110 | 13                       | 10   | 9    | 18   | 12   | 12   | 1             | 1     | 1     | +     | 1     | +     | +                  |
| 111-115 | 2                        | 3    | 2    | 5    | 1    | 1    | +             | +     | +     | —     | +     | +     | +                  |
| 116-120 | —                        | 1    | —    | 1    | —    | +    | +             | +     | +     | —     | +     | +     | +                  |

Mean catch/  
day's fish.

| kg.            | 19,244 | 27,609 | 19,470 | 10,249 | 14,774 | 12,673 | 6,043 | 3,931 | 6,047 | 5,007 | 5,837 | 7,096 | 9,197 <sup>1)</sup> |
|----------------|--------|--------|--------|--------|--------|--------|-------|-------|-------|-------|-------|-------|---------------------|
| Year-classes   |        |        |        |        |        |        |       |       |       |       |       |       |                     |
| 1952.....      | —      | —      | —      | —      | —      | 8      | —     | —     | —     | —     | —     | 4     | 100                 |
| 1951.....      | —      | —      | —      | —      | —      | 37     | —     | —     | —     | —     | —     | 53    | 212                 |
| 1950.....      | —      | —      | —      | —      | 3      | 155    | —     | —     | —     | 2     | 37    | 361   | 433                 |
| 1949.....      | —      | —      | —      | +      | 95     | 412    | —     | —     | 3     | 127   | 505   | 411   | 142                 |
| 1948.....      | —      | —      | 5      | 129    | 238    | 135    | —     | 1     | 130   | 246   | 178   | 55    | 29                  |
| 1947.....      | —      | 4      | 57     | 215    | 199    | 55     | 1     | 28    | 221   | 226   | 88    | 31    | 18                  |
| 1946.....      | 2      | 15     | 346    | 290    | 182    | 69     | 41    | 193   | 296   | 179   | 60    | 24    | 17                  |
| 1945.....      | 26     | 136    | 136    | 70     | 56     | 25     | 99    | 202   | 90    | 44    | 19    | 11    | 9                   |
| 1944.....      | 187    | 402    | 95     | 46     | 69     | 23     | 300   | 291   | 66    | 41    | 21    | 10    | 11                  |
| 1943.....      | 274    | 212    | 108    | 68     | 37     | 16     | 263   | 128   | 55    | 35    | 15    | 11    | 9                   |
| 1942.....      | 112    | 63     | 51     | 33     | 31     | 12     | 76    | 57    | 31    | 24    | 16    | 8     | 5                   |
| 1941.....      | 75     | 32     | 39     | 30     | 24     | 15     | 38    | 36    | 23    | 21    | 15    | 6     | 5                   |
| 1940.....      | 105    | 33     | 42     | 38     | 30     | 15     | 56    | 24    | 22    | 18    | 10    | 5     | 4                   |
| 1939.....      | 56     | 30     | 34     | 28     | 16     | 8      | 31    | 14    | 21    | 13    | 12    | 3     | 3                   |
| 1938.....      | 55     | 15     | 28     | 20     | 2      | 4      | 29    | 6     | 10    | 9     | 5     | 2     | 1                   |
| 1937 and older | 108    | 58     | 59     | 33     | 17     | 11     | 65    | 19    | 31    | 15    | 18    | 5     | 2                   |

<sup>1)</sup> provisional figures.



Table 36. Saithe caught by German trawlers off the Norwegian coast (1000 kg.)

| Fishing season (April to March) . . . . | 1950/51 | 1951/52 | 1952/53 | 1953/54 | 1954/55 | 1955/56 <sup>1)</sup> |
|-----------------------------------------|---------|---------|---------|---------|---------|-----------------------|
| Lofoten banks . . . . .                 | 20,677  | 9,659   | 16,359  | 7,430   | 13,288  | 14,376                |
| Svinøy area . . . . .                   | 8,646   | 12,513  | 3,837   | 7,487   | 7,848   | 5,467                 |
| Total . . . . .                         | 29,323  | 22,172  | 20,196  | 14,917  | 21,136  | 19,843                |

<sup>1)</sup> provisional figures.

year-classes. The density of the stock was therefore about the same as in 1955. On the Lofoten banks, however, the population density increased considerably, due to the strength of the 1949 year-class, which predominated there also, and the 1950 class, which produced an increase in the catches, especially in March and April 1956 and 1957.

The 1951 and 1952 year-classes also seemed to be of more than normal strength, as judged by the output of the fishery in autumn 1956. As there are again several successive rich year-classes after a long period of poor broods, the outlook for the fishery off the Norwegian coast seems to be more favourable than for that in Icelandic waters. Since even rich year-classes can nowadays survive the fishery only a relatively short time, studies are undertaken by Norway and Germany of fishing mortality to find out whether the fishery obtains the optimal yield from the stock or not.

The differences in the annual landings shown in Table 36 result only in part from the fluctuations in year-class strength. The decrease in the landings from 1950—51 to 1953—54 is easily accounted for by the disappearance of the rich 1944 and 1943 year-classes and the lack of good broods to replace them. The increase in landings from the Lofoten banks in the last two years is due to the exceptionally strong 1949—51 classes, which have ensured a plentiful stock in this area. In addition, we may interpret the small yield at Svinøy in 1952—53, which was obtained despite the relatively great density of stock, as a result of commercial re-

strictions. On biological grounds, however, the very sharp decline in the 1951—53 landings from the Lofoten banks is hard to understand. It is attributable to the failure of the 1944 year-class, although the same year-class gave rise to record catches on the Svinøy spawning grounds. Possibly some changes in migration habits may have occurred. Another explanation seems to be offered by the results of a cruise off the Norwegian coast with the "Anton Dohrn" in November 1956. Internal waves were found in the layer between the Atlantic water of the Norwegian Current and the bottom water; these may have caused strong currents on the shelf which affected the behaviour of the saithe shoals and so the yield of the fishery. The internal waves are probably the consequence of certain atmospheric conditions, connected with the areas of low pressure on the open Atlantic. This explanation takes account of the curious "weather sensitivity" of saithe, the dependence of the daily catch on wind direction. Further studies of this important correlation will be made on the "Anton Dohrn's" next cruise to the Lofotens in November 1957.

It is thus evident that besides the fundamental changes in population which result from the variations in year-class strength, the environment is also very important; the distribution of the food of the fish may determine the population density and cause us to misjudge the absolute strength of the population. Such factors must have a considerable effect on the yield of a fishery.

ULRICH SCHMIDT

## WHITING

### North Sea Stock

#### British Statistics

The data in Table 38 are presented as a summary of landings by British steam trawlers from

1954 onwards. The summary for 1953 will be found in Ann. Biol., Vol. X.

R. JONES, W. MAIN

Table 38. Landings of whiting by British steam trawlers from the North Sea in 1954—1956

| 1954<br>Quarterly<br>period | North of 57°30'N.            |                                      |                              | 55°N. to 57°30'N.                    |                              |                                      | South of 55°00'N.            |                                      |                              | All areas                            |                              |                                      |
|-----------------------------|------------------------------|--------------------------------------|------------------------------|--------------------------------------|------------------------------|--------------------------------------|------------------------------|--------------------------------------|------------------------------|--------------------------------------|------------------------------|--------------------------------------|
|                             | Weight<br>landed<br>100 cwt. | 100 hrs. landed/<br>fishing 100 hrs. | Weight<br>landed<br>100 cwt. | 100 hrs. landed/<br>fishing 100 hrs. | Weight<br>landed<br>100 cwt. | 100 hrs. landed/<br>fishing 100 hrs. | Weight<br>landed<br>100 cwt. | 100 hrs. landed/<br>fishing 100 hrs. | Weight<br>landed<br>100 cwt. | 100 hrs. landed/<br>fishing 100 hrs. | Weight<br>landed<br>100 cwt. | 100 hrs. landed/<br>fishing 100 hrs. |
| Jan.—Mar.                   | 565                          | 528                                  | 107                          | 138                                  | 295                          | 47                                   | 86                           | 1366                                 | 6                            | 789                                  | 2188                         | 36                                   |
| Apr.—June                   | 520                          | 583                                  | 89                           | 156                                  | 706                          | 22                                   | 35                           | 834                                  | 4                            | 711                                  | 2123                         | 33                                   |
| July—Sept.                  | 198                          | 443                                  | 45                           | 171                                  | 826                          | 21                                   | 38                           | 729                                  | 5                            | 407                                  | 1997                         | 20                                   |
| Oct.—Dec.                   | 394                          | 461                                  | 85                           | 217                                  | 712                          | 30                                   | 50                           | 917                                  | 5                            | 661                                  | 2091                         | 32                                   |
| Year                        | 1677                         | 2015                                 | 83                           | 682                                  | 2539                         | 27                                   | 209                          | 3846                                 | 5                            | 2568                                 | 8399                         | 31                                   |
| 1955                        |                              |                                      |                              |                                      |                              |                                      |                              |                                      |                              |                                      |                              |                                      |
| Jan.—Mar.                   | 646                          | 542                                  | 119                          | 87                                   | 346                          | 25                                   | 29                           | 1043                                 | 3                            | 762                                  | 1931                         | 39                                   |
| Apr.—June                   | 329                          | 483                                  | 68                           | 121                                  | 654                          | 18                                   | 18                           | 675                                  | 3                            | 468                                  | 1812                         | 26                                   |
| July—Sept.                  | 213                          | 438                                  | 49                           | 216                                  | 628                          | 34                                   | 39                           | 577                                  | 7                            | 469                                  | 1644                         | 29                                   |
| Oct.—Dec.                   | 592                          | 572                                  | 103                          | 203                                  | 432                          | 47                                   | 46                           | 786                                  | 6                            | 841                                  | 1790                         | 47                                   |
| Year                        | 1780                         | 2035                                 | 87                           | 627                                  | 2060                         | 30                                   | 132                          | 3081                                 | 4                            | 2540                                 | 7177                         | 35                                   |
| 1956                        |                              |                                      |                              |                                      |                              |                                      |                              |                                      |                              |                                      |                              |                                      |
| Jan.—Mar.                   | 691                          | 474                                  | 146                          | 194                                  | 314                          | 62                                   | 12                           | 803                                  | 1                            | 897                                  | 1592                         | 56                                   |
| Apr.—June                   | 422                          | 448                                  | 94                           | 83                                   | 586                          | 14                                   | 12                           | 492                                  | 2                            | 578                                  | 1525                         | 38                                   |
| July—Sept.                  | 215                          | 420                                  | 51                           | 208                                  | 582                          | 36                                   | 29                           | 530                                  | 5                            | 452                                  | 1532                         | 30                                   |
| Oct.—Dec.                   | 375                          | 461                                  | 81                           | 170                                  | 391                          | 43                                   | 28                           | 679                                  | 4                            | 573                                  | 1532                         | 37                                   |
| Year                        | 1703                         | 1803                                 | 94                           | 655                                  | 1873                         | 35                                   | 81                           | 2504                                 | 3                            | 2440                                 | 6181                         | 39                                   |

# Herring

## INTRODUCTION

Contributions to this report (8th) of the Herring Committee have been received from the following countries: —

Belgium :  
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J. YUDANOV  
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In the main the material has been arranged according to the areas given in *Annales Biologiques*, Vol. XII, 1955. Some discrepancies, however, arise through the circumstance that occasionally a contribution — in itself a natural whole — covers parts of two areas.

Features of outstanding importance in the Distant Northern Seas are the comprehensive

Russian investigations of the spawning areas of the Atlanto-Scandian herring. It is easily agreed that a better knowledge of the fluctuations in the different spawning communities would open broad perspectives in the further investigations of this important herring stock. It is also well worth noting that the dominant year-classes of the herring in the Barents Sea are the same as for the Atlanto-Scandian herring. Thus the Barents Sea would appear to be an important nursery area for this herring tribe.

For the Near Northern Seas the decline in yields from the southern North Sea is noteworthy. This development has been followed with concern and apprehension for some time. As will be known, plans are now being developed for an intensive tagging scheme on the Bløden nursery grounds in order to elucidate certain aspects of this important problem.

A highly interesting project in the Baltic-Belt Seas is the Swedish herring tagging experiments. The preliminary results seem very promising. Of great interest is also the Russian paper on the connexion between the quantitative estimation of herring larvae and the subsequent strength of the year-broods.

OLAV AASEN

## A. Distant Northern Seas

### YOUNG STAGES

#### Investigations of the Nursery Areas of the Atlanto-Scandian Herring in 1956

An extensive study of the spawning areas of the Atlanto-Scandian herring was carried out by the Polar Institute in 1955—1956. In 1956 the area surveyed extended southwards to the northern group of the Hebrides and northwards to Sørøya (West Finnmark). The whole area was surveyed simultaneously by the research vessels "Academician Berg" and "Professor Mesyatsev".

Special consideration was given to the study of the herring larvae distribution. The main spawning grounds (the shallow waters off the Scottish islands and within the stretch Karmøya—Halten Bank off the west coast of Norway) were surveyed twice with 20—25 days interval; the waters off the Faroes were surveyed three times.

Catches of larvae were made with ichthyoplankton nets and on certain occasions with a bottom trawl for fry. More spawning grounds were investigated and more samples of ichthyoplankton were taken in 1956 than in 1955. In 1956 the research staff of the research vessels "Academician Berg" and "Professor Mesyatsev" worked 219 oceanographical stations and took 592 samples of ichthyoplankton whereas in 1955 94 complex oceanological stations were worked and 224 ichthyoplankton samples were taken. In addition, six stations were worked and 20 ichthyoplankton samples taken by the trawler N 96 "Russia" in April (3.—7.) 1956.

From these large-scale investigations of the main nursery grounds the following characteristic features of the spawning places and intensity of spawning in the different areas were revealed:—

1. In all areas surveyed spawning was rather extensive and started earlier than in 1955.

2. The main spawning of herring off the south-western coast of Norway shifted considerably to the north and took place mainly over the southern

banks of Norwegian shallow waters. Further to the north (Frøya Bank and especially at the Halten and Sklinna Banks) less herring larvae were found.

3. In the area of the Hebrides intensive spawning of herring was observed in depths less than 100 m., and judging by the size of the larvae, it took place from 10. February to 1. March; the spawning in the south-western Orkney-Shetland shallow waters started a week later. The spawning of the herring in the north-eastern shallow waters off the Shetlands started still later. Mass spawning of herring in the eastern part of the waters off Scotland was observed to take place from 12. to 22. February, i.e., a little earlier than in region XI and later than in the areas off the south-western coast of Norway. Spawning took place latest in the water off the Faroe islands, where concentrations of spawning herring were observed through the later half of March.

4. On the second survey of the main spawning areas made 20—25 days later far less herring larvae were found than on the first survey. This sharp decline in the number of larvae was partly due to drifting from the spawning grounds. The noticeable increase in size, which was observed during the second survey, was caused not only by growth but also by immigration (drifting) from the nursery areas situated further to the south.

5. The geographically separated areas and the difference in time of spawning (caused by different environmental conditions) indicate that the Atlanto-Scandian herring consists of separate stocks. Extensive taggings in the spawning areas will facilitate further studies of the reproduction cycle and of the different races.

6. The recruitment to the herring stock exceeded in 1956 the 1955 level in all areas.

J. YUDANOV



## COMMERCIAL FISH

The Herring Stock in the Southern  
Barents Sea in 1956

(Figures 1 and 2)

## Age composition

The abundant 1953 year-class dominated in the southern part of the Barents Sea in 1956. The 1950 year-class was well represented and yielded high catches at the Murman coast from 1952 to 1955 (see Figure 1). In 1956 however, only a small contingent of this year-class, characterized by slow rate of growth, remained in the Barents Sea. Herring about 22 cm. long were encountered in the first half of the year whereas by the end of the year the length was 20.5 cm. The length was measured from the tip of the snout to the end of the middle rays of the caudal fin. The 1951 and 1952 year-classes were only sparsely represented in the catches.

In 1956 the catches consisted mainly of 4-year-olds of the abundant 1953 year-class with a length of about 18 cm. In the coastal areas this year-class formed up to 75% of the catches and in the open sea up to 35%. The younger classes of 1954 and 1955 occurred in the Barents Sea only in small numbers.

## Distribution of the 1953 year-class

The 0-group of the 1953 year-class occurred at the coast of Murman in July. The most extensive distribution was observed in October—November. This year-class was abundant during the first two years of life.

In October 1953 great numbers of 5 to 8 cm. fish occurred in all areas of the southern part of the Barents Sea. In order to illustrate the distribution of this year-class we have used the observational data obtained from the research vessel "Persey-II" (Figure 2, p. 170).

The 1953 year-class was also abundant in the eastern parts of the sea (Figure 2 A,B). The wide area of distribution must evidently be ascribed to favourable hydrological conditions; during these years warm-water species of plankton were carried far to the east. In their third year of life (2+) herring of the 1953 year-class left the area adjacent to Nowaya Zemlya (Figure 2 C).

At the end of the winter 1956 the herring of the 1953 brood occurred mainly in the Murman shallows (Figure 2 D). Arrows show the movement of this brood from Konin Nos to the Murman coast

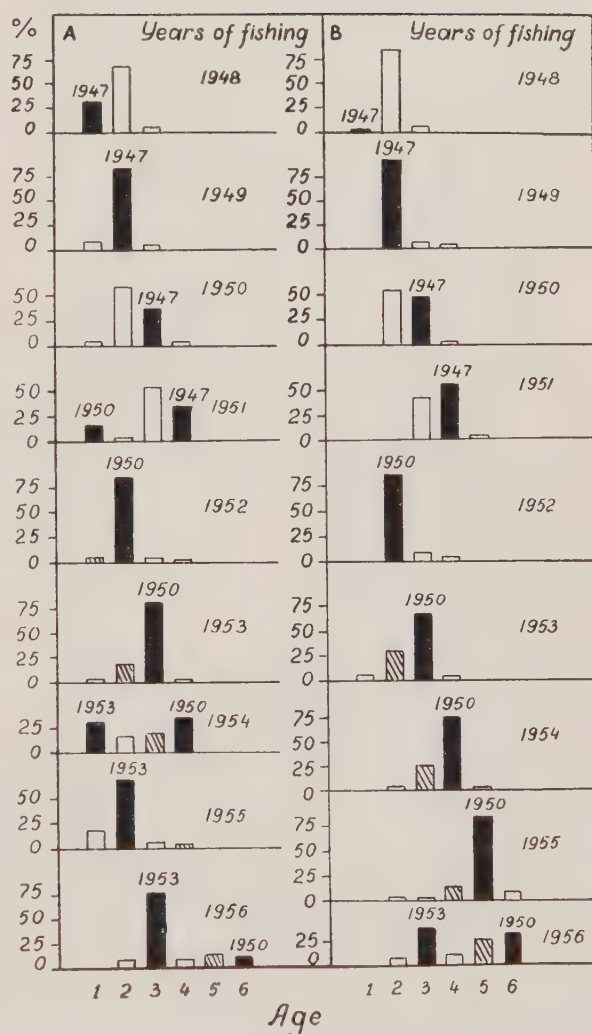


Figure 1. Age composition of herring in the Barents Sea.  
A = coastal areas. B = open-sea areas.

in the summer of 1956, and from the Murman coast to the open sea in autumn. Figure 2 D shows also the area where the herring stocks of this brood accumulated in the winter of 1956—57 (boundary indicated by broken line.)

The herring of the 1953 year-class are characterized by slow rate of growth which allows to assume that a considerable part of these herring will be present in the Barents Sea throughout the year of 1957.

I. V. SHUTOVA-KORZH

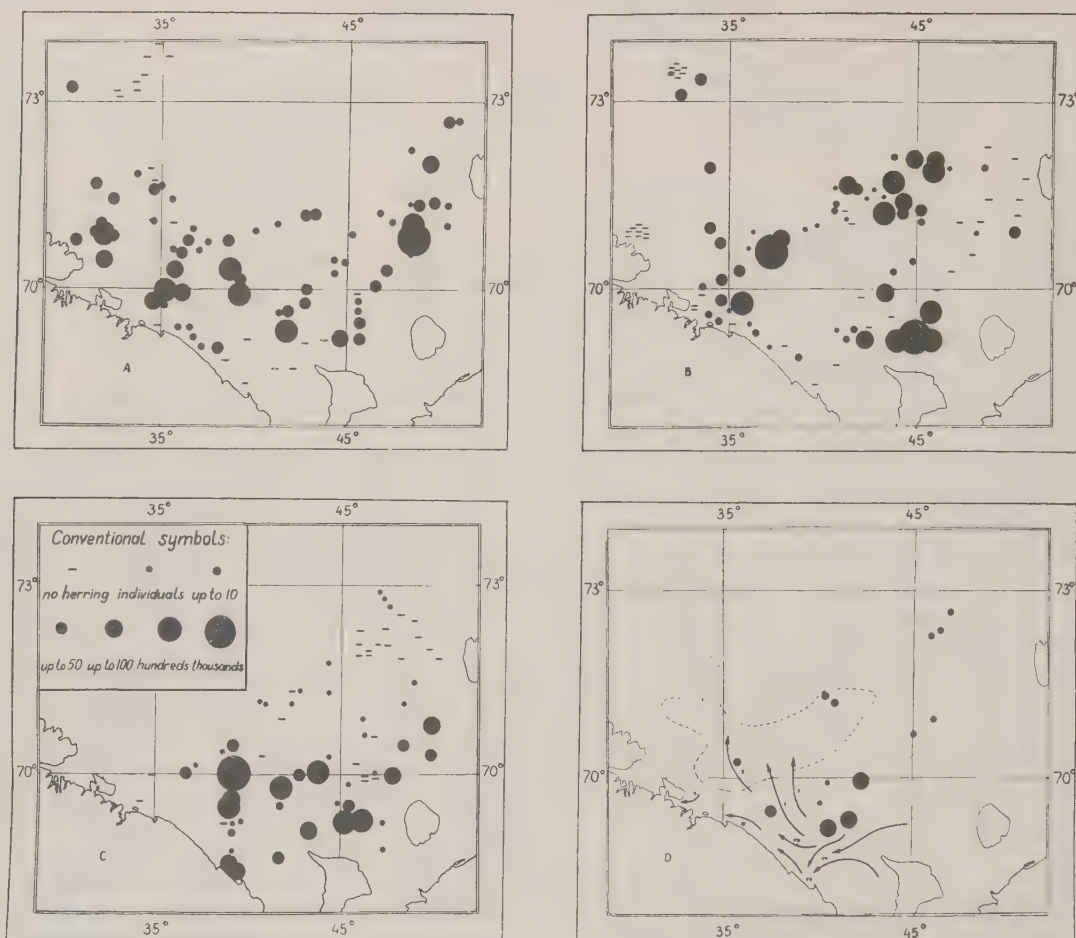


Figure 2. Distribution of herring of the 1953 year-class during their first years of life.

A -- one-year-old fish, January—March 1954.

B = 2-year-old fish, January—March 1955.

C = 2+ fish, October—December 1955.

D = 3-year-old fish, January—February 1956.

1. Migrations of herring from July to October.
2. Supposed places of wintering in 1956—57.

### Tagging Experiments

(Figures 3-4; Tables 1-2)

The herring tagging experiments in the Norwegian Sea carried out by the Soviet Union started in 1953 with the object of studying the migrations of the adult Atlanto-Scandian herring. The herring have been tagged with external "flag" tags of Danish type. From 1953 to 1956 tagging was undertaken in the following areas: Faroese and Scottish waters (February-April); Bear Island and Jan Mayen areas and in the waters S.E. of Iceland (June-September); north of the Faroes (November-December) (see Figure 3).

During the four years considered 22,000 herring were tagged. So far, only 0.15% of the fish have been returned (Tables 1 and 2). This low percentage

of recovery is believed to be caused by the small numbers of fish being tagged at localities scattered over a wide area, as well as by the difficulty of detecting the tagged herring in large catches.

The greatest number of tags were returned from herring tagged in August 1954 and 1955; of the herring tagged in winter/spring in Shetland waters, no returns.

Twenty-two tagged herring were recovered off the Norwegian coast during the spawning season and 12 on the feeding grounds, 4 of these fish had Norwegian tags, 3 specimens are not included in the tables because of inaccurate data. Figure 4 shows the distribution of recaptures (arrow heads), the black circles denote the tagging localities.

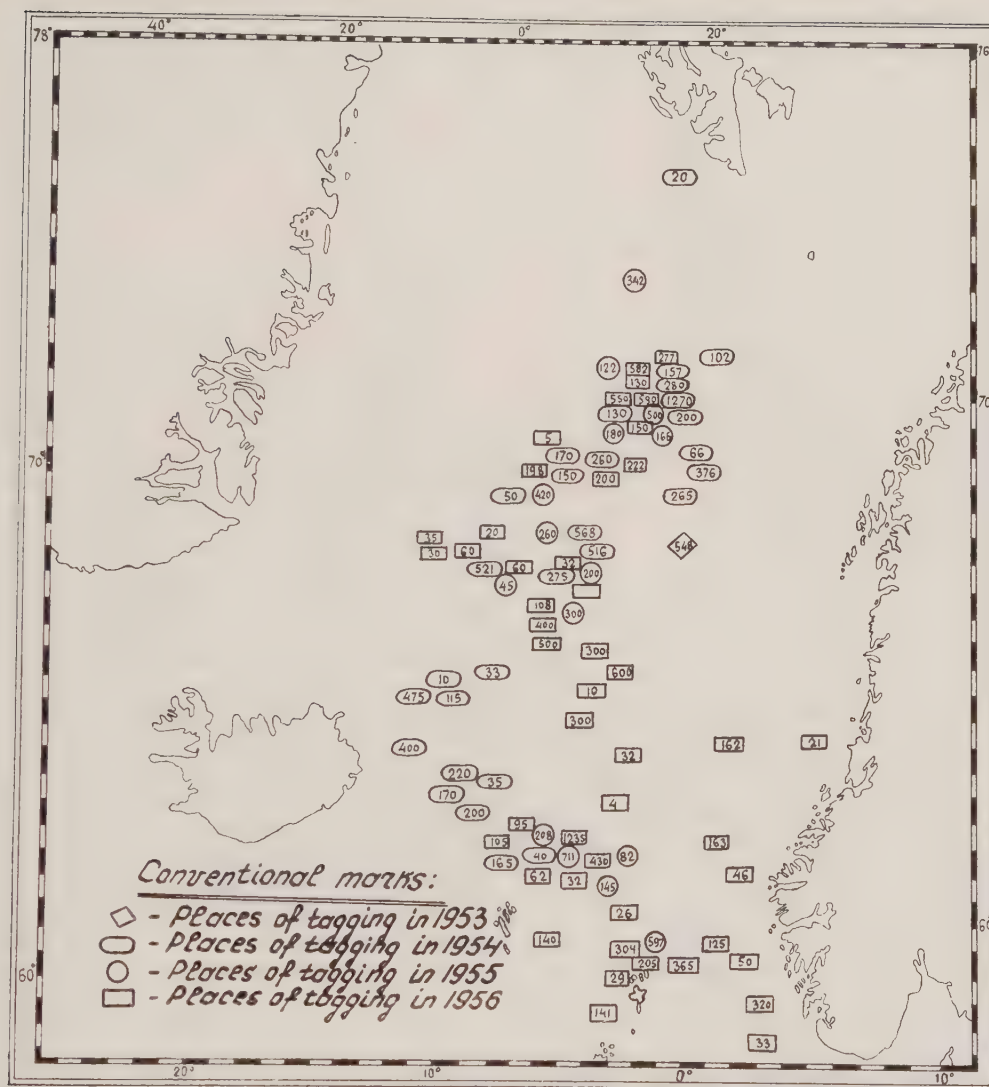


Figure 3. Herring tagging localities in the years 1953-1956. The framed numerals indicate the number of fish tagged.

Table 1. Number of herring tagged in the Norwegian Sea from 1953 to 1956

|                 | 1953          |              |      | 1954          |              |      | 1955          |              |      | 1956          |              |      |
|-----------------|---------------|--------------|------|---------------|--------------|------|---------------|--------------|------|---------------|--------------|------|
|                 | Number tagged | Returns Nos. | %    | Number tagged | Returns Nos. | %    | Number tagged | Returns Nos. | %    | Number tagged | Returns Nos. | %    |
| January .....   | —             | —            | —    | —             | —            | —    | 437           | —            | —    | 101           | —            | —    |
| February .....  | —             | —            | —    | —             | —            | —    | —             | —            | —    | 1374          | —            | —    |
| March .....     | —             | —            | —    | —             | —            | —    | 597           | —            | —    | 470           | —            | —    |
| April .....     | —             | —            | —    | —             | —            | —    | 711           | —            | —    | 1942          | 1            | 0.07 |
| May .....       | —             | —            | —    | 41            | 1            | 2.30 | —             | —            | —    | 256           | —            | —    |
| June .....      | 548           | 1            | 0.18 | —             | —            | —    | —             | —            | —    | —             | —            | —    |
| July .....      | —             | —            | —    | 2127          | 4            | 0.18 | 248           | —            | —    | 2784          | 1            | 0.04 |
| August .....    | —             | —            | —    | 4635          | 15           | 0.32 | 1544          | 10           | 0.65 | 1081          | 1            | 0.09 |
| September ..... | —             | —            | —    | —             | —            | —    | 759           | —            | —    | 1600          | —            | —    |
| December .....  | —             | —            | —    | 583           | —            | —    | —             | —            | —    | —             | —            | —    |
| Total .....     | 548           | 1            | 0.18 | 7386          | 20           | 0.27 | 4341          | 10           | 0.23 | 9735          | 3            | 0.03 |

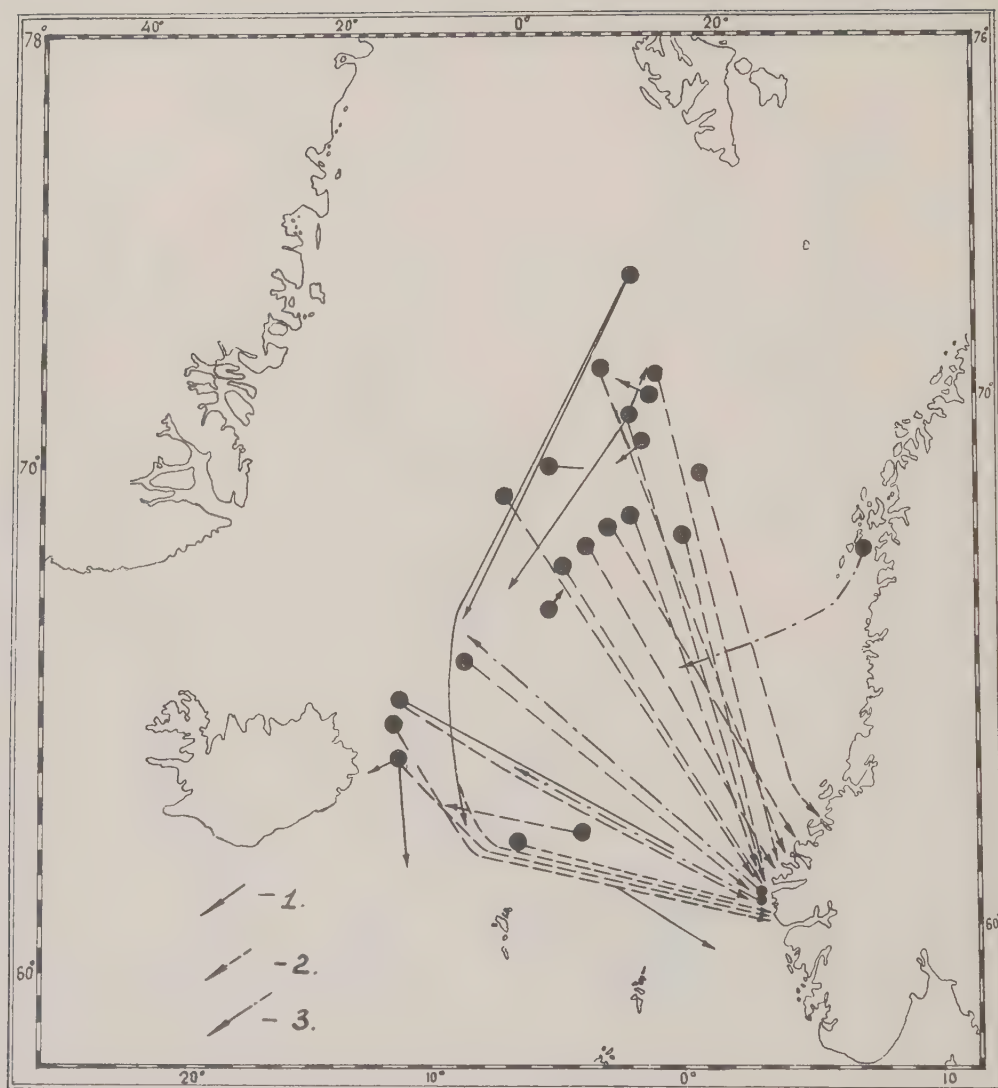


Figure 4. Distribution of tagged herring recovered in 1953—1956.

Explanation of symbols:—

1. Returned in less than six months after tagging.

2. Returned after more than six months at liberty.

3. Tagged by the Norwegians.

Within a year migrating adult Atlanto-Scandian herring may cover considerable distances, the maximum distance observed is more than 1500 nautical miles. After spawning the mature Norwegian herring migrate to the feeding grounds in the northern part of the Norwegian Sea. From the northern feeding grounds (west of Bear Island and Bank "600") the herring move south-westwards along the edges of the East Iceland Current, and further on to places of wintering north of the Faroes. The herring move with a speed of up to 7 nautical miles a day. The herring feeding in

Table 2. Number of recaptures of herring tagged in 1953—56

| Years of return | Year of tagging |      |      |      | Total |
|-----------------|-----------------|------|------|------|-------|
|                 | 1953            | 1954 | 1955 | 1956 |       |
| 1954 .....      | 1               | 2    | —    | —    | 3     |
| 1955 .....      | —               | 13   | 4    | —    | 17    |
| 1956 .....      | —               | 5    | 6    | 3    | 14    |
| Total .....     | 1               | 20   | 10   | 3    | 34    |

waters north-east of Iceland have their spawning grounds at the south-western coast of Norway.

Despite the minor scale, the tagging experiments on Atlanto-Scandian herring furnish important information on the migrations of adult Norwegian herring in the open sea.

A. P. WILSON



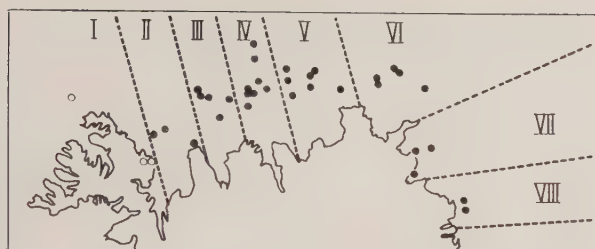


Figure 5. Localities of sampling in 1956.

### The Icelandic North Coast Herring in 1956

(Figures 5-7; Tables 3-11)

The summer of 1956 represented the 12th poor herring fishing season in the waters north and east of Iceland. The catches were, however, somewhat better than they had been since 1947 and, consequently, more vessels participated in the fishing (187) than in 1955 (132).

In Figure 5 the localities from which the samples originated are shown and it appears that the main fishing took place rather far offshore, except off the east coast. Generally the fish were found nearer to the coast than in 1955. In Figure 5 the fishing area has been divided into sections, which will be referred to later, but special attention shall be drawn to the 3 samples in Section I, which will be indicated by Nos. 1B, 26, and 33 in the tables. These three samples are entirely different from the main bulk of the material. The season was unusually short this year as only few catches were taken after the beginning of August. It must, however, be emphasized that in July there were more fish on the grounds than through many previous years.

The length of the north coast herring in 1956 can be seen from Table 3. It will immediately be noted that not a single fish of the fat herring type (less than 30 cm.) was present which is rather unusual. The average length of all herring caught during June-August proved to be 35.89 cm., which was a little higher than in 1955 (35.70 cm.). The highest frequency was at 36 cm. In July, when practically the whole catch was taken, the average size was somewhat higher (35.96) than in August (35.30), which shows that the largest fish left the banks about the end of July. As usual the tagged herring proved to be somewhat longer (36.21 cm.) than the herring which were landed in Siglufjörður, no doubt owing to the fact that the first mentioned were measured alive.

When comparing the length distribution of the various categories it must be remembered that the July samples (except No. 26) came from

Table 3. Size distribution of north coast herring (°/00)

| cm.        | June-<br>July | Aug.  | Tagged<br>Total herring | No.<br>1B | No.<br>26 | No.<br>33 |
|------------|---------------|-------|-------------------------|-----------|-----------|-----------|
| 41 .....   | +             | —     | +                       | —         | —         | —         |
| 40 .....   | 1             | —     | 1                       | —         | —         | —         |
| 39 .....   | 17            | —     | 15                      | 16        | —         | —         |
| 38 .....   | 112           | 40    | 104                     | 137       | 10        | 33        |
| 37 .....   | 260           | 199   | 253                     | 319       | 28        | 30        |
| 36 .....   | 277           | 320   | 283                     | 262       | 114       | 50        |
| 35 .....   | 169           | 169   | 169                     | 146       | 85        | 80        |
| 34 .....   | 104           | 119   | 106                     | 82        | 229       | 160       |
| 33 .....   | 50            | 83    | 54                      | 26        | 316       | 370       |
| 32 .....   | 7             | 35    | 10                      | 8         | 200       | 170       |
| 31 .....   | 2             | 27    | 3                       | 2         | 28        | 100       |
| 30 .....   | 1             | 8     | 2                       | 1         | —         | 30        |
| Total ..   | 1000          | 1000  | 1000                    | 1000      | 1000      | 1000      |
| Number     | 2874          | 373   | 3285                    | 8260      | 35        | 100       |
| Av. length | 35.96         | 35.30 | 35.89                   | 36.21     | 33.60     | 33.18     |

Table 4. Age of north coast herring in 1956 (°/00)

| Age             | Year | NN   | NS   | ISPR | ISUM | ?1)  | Total |
|-----------------|------|------|------|------|------|------|-------|
| 3 .....         | 1953 | —    | —    | 1    | —    | —    | +     |
| 4 .....         | 1952 | —    | —    | 6    | 43   | —    | 5     |
| 5 .....         | 1951 | 2    | 2    | 20   | 65   | 57   | 14    |
| 6 .....         | 1950 | 20   | 98   | 140  | 65   | 86   | 85    |
| 7 .....         | 1949 | 5    | 4    | 362  | 208  | —    | 158   |
| 8 .....         | 1948 | 25   | 63   | 29   | 65   | 171  | 39    |
| 9 .....         | 1947 | 45   | 165  | 6    | 36   | 157  | 53    |
| 10 .....        | 1946 | 38   | 69   | 60   | 122  | 215  | 61    |
| 11 .....        | 1945 | 67   | 45   | 334  | 310  | —    | 181   |
| 12 .....        | 1944 | 101  | 215  | 17   | 36   | 86   | 83    |
| 13 .....        | 1943 | 104  | 175  | 2    | 29   | 28   | 69    |
| 14 .....        | 1942 | 24   | 59   | 5    | 7    | 57   | 23    |
| 15 .....        | 1941 | 57   | 55   | 7    | —    | 100  | 35    |
| 16 .....        | 1940 | 71   | 12   | 9    | 14   | 43   | 32    |
| 17 .....        | 1939 | 100  | 20   | 2    | —    | —    | 39    |
| 18 .....        | 1938 | 156  | 6    | —    | —    | —    | 56    |
| 19 .....        | 1937 | 115  | 12   | —    | —    | —    | 42    |
| 20 .....        | 1936 | 29   | —    | —    | —    | —    | 10    |
| 21 .....        | 1935 | 25   | —    | —    | —    | —    | 9     |
| 22 .....        | 1934 | 16   | —    | —    | —    | —    | 6     |
| Total .....     |      | 1000 | 1000 | 1000 | 1000 | 1000 | 1000  |
| Number .....    |      | 989  | 488  | 1122 | 139  | 70   | 2808  |
| 2) .....        |      | 161  | 6    | 0    | 1    | 270  | 438   |
| Grand total ... |      | 1150 | 494  | 1122 | 140  | 340  | 3246  |
| °/00 .....      |      | 396  | 170  | 386  | 48   | —    | 1000  |
| Average age ... |      | 14.9 | 11.2 | 8.6  | 9.0  | 10.1 | 11.3  |

1) Scales not fit for type determination.

2) Scales not fit for age reading.

NN = North Norway type.

NS = South Norway Type.

ISPR = Icelandic spring spawners.

ISUM = Icelandic summer spawners.

purse-seine catches whereas the August samples (except No. 33) originated from drift-net herring.

The table reveals that the samples 1B, 26, and 33 differ very much in length from the main stock. They are much smaller, the average lengths varying from 33.18 to 33.91 cm. These three samples consisted entirely of Icelandic herring as will be mentioned later.

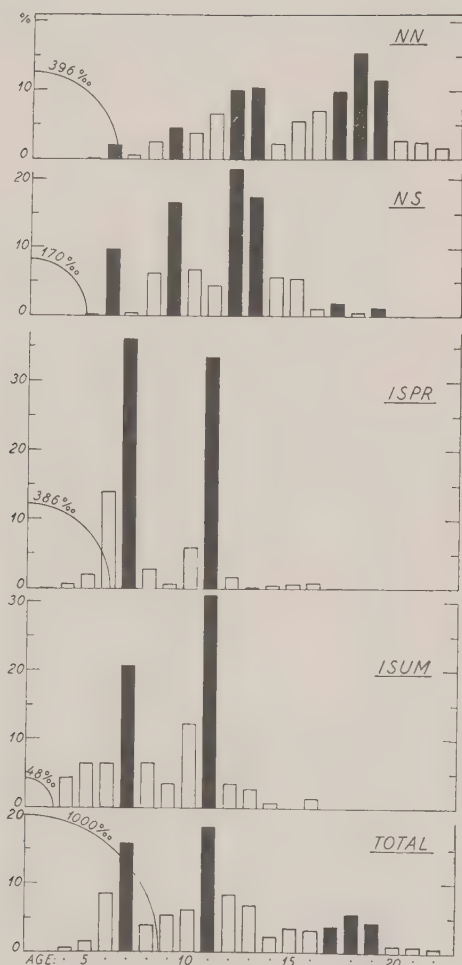


Figure 6. Age distribution in the different tribes in 1956, and the relative number of fish in each tribe (circles at left).

The age distribution of the north coast herring in 1956 appears from Table 4 and Figure 6.

There were 20 broods in the catches aged from 3 to 22 years. The predominant year-classes in the north Norwegian tribe were the same as in 1954 and 1955, namely those from 1937—39 and 1943—44, but in the southern tribe the 1938 year-class is nearly absent whereas the 1947 year-class is strong. The 1934 year-class, which has given high yields through many years both at northern Iceland and Norway is now practically exhausted, being 22 years old. The pattern of distribution was in 1956 very similar to that of 1955, but with one important exception: 6-year-old herring appeared in both tribes as a relative dominant. This fact is worth noting because herring of Norwegian origin does not normally contribute much to the north coast catches until they are 8—10 years old.

Table 5. The age distribution of the north coast herring proper and of the herring in samples 1B, 26, and 33

| Age         | Brood | N. coast<br>herring | No. 1B | No. 26 | No. 33 |
|-------------|-------|---------------------|--------|--------|--------|
| 3           | 1953  | +                   | —      | —      | —      |
| 4           | 1952  | 5                   | —      | 37     | 31     |
| 5           | 1951  | 14                  | 32     | 293    | 282    |
| 6           | 1950  | 85                  | 323    | 256    | 115    |
| 7           | 1949  | 158                 | 387    | 269    | 208    |
| 8           | 1948  | 39                  | 32     | 48     | 31     |
| 9           | 1947  | 53                  | —      | 12     | 51     |
| 10          | 1946  | 61                  | —      | —      | 31     |
| 11          | 1945  | 181                 | 226    | 61     | 167    |
| 12          | 1944  | 83                  | —      | —      | 21     |
| 13          | 1943  | 69                  | —      | 12     | 11     |
| 14          | 1942  | 23                  | —      | 12     | 11     |
| 15          | 1941  | 35                  | —      | —      | —      |
| 16          | 1940  | 32                  | —      | —      | —      |
| 17          | 1939  | 39                  | —      | —      | —      |
| 18          | 1938  | 56                  | —      | —      | 31     |
| 19          | 1937  | 42                  | —      | —      | —      |
| 20          | 1936  | 10                  | —      | —      | 10     |
| 21          | 1935  | 9                   | —      | —      | —      |
| 22          | 1934  | 6                   | —      | —      | —      |
| Total       |       | 1000                | 1000   | 1000   | 1000   |
| Number      |       | 2808                | 31     | 82     | 96     |
| ?           |       | 438                 | 4      | 18     | 4      |
| Grand Total |       | 3246                | 35     | 100    | 100    |
| Average age |       | 11.3                | 8.5    | 6.5    | 7.8    |

Turning now to the two Icelandic tribes it appears that in 1956 there are the same year-broods with similar relative strength as in 1955. It seems therefore that there has been no new recruitment to these stocks from 1955 to 1956.

Table 5 has been compiled in order to show the difference in age between the main stock on one hand and samples 1B, 26, and 33 on the other hand. As could be expected the herring in these samples are much younger than in the main stock, the average age being 3—5 years less.

The average age of the north coast herring was somewhat higher in 1956 (11.3 years) than it was in 1955 (11.1) and 1954, owing to higher age of the Icelandic tribes and the lack of fat herring in the catches. During the period 1953—56 the average age of the Norwegian tribes has been rather constant (NN, 14.9—15.0 years; NS, 11.1—11.4 years) while that of the Icelandic tribes has been increasing.

The average age of the Icelandic spring spawners was more than 2 years higher in 1956 than in 1953, the corresponding increase for the summer spawners being exactly 1 year. The whole stock has consequently showed a slight trend to increase in age from 10.7 years on an average in 1954, through 11.1 in 1955, to 11.3 in 1956.

The composition of the whole stock as to tribes is shown in Table 6. It appears clearly that there

Table 6. Relative strength of tribes in 1956

| Tribes      | Main stock | No. 1B | No. 26 | No. 33 |
|-------------|------------|--------|--------|--------|
| NN .....    | 396        | —      | —      | —      |
| NS .....    | 170        | —      | —      | —      |
| ISPR .....  | 386        | 938    | 939    | 101    |
| ISUM .....  | 48         | 62     | 61     | 899    |
| Total ..... | 1000       | 1000   | 1000   | 1000   |

was no herring of Norwegian origin in the three exceptional samples and that two of these (1B and 26), which were taken in June and July, comprised nearly entirely Icelandic spring spawners whereas the last one (33), which was taken in August, contained mostly summer spawners.

In 1956 there were relatively fewer NN (396‰) and ISPR (386) than in 1955, about the same number of NS (170 against 169), and relatively more ISUM (48 against 23‰).

It is of special interest to note the relative strength of the tribes if we move from west to east over the fishing area as indicated in Figure 5, where all samples are divided into 8 groups, marked by I to VIII. A survey is given in Table 7.

Taking into account that some of the samples in the sections I, II, VII, and VIII are taken near the coast it appears very clearly that the NN-tribe increased greatly from west to east and the same applies partly to the NS and none of them is well represented in the westernmost sections (I and II) where the east-going coastal current is stronger than farther east. Quite the reverse applies to the ISPR herring, and ISUM herring is only found in relatively great numbers in coastal waters farthest west.

If we consider the relative frequency of the tribes during the season there is a pronounced decrease of the Norwegian tribes, but increase of the Icelandic ones. The relative proportions of the two groups of tribes in the catches were as follows (‰): —

|              | Norwegian tribes | Icelandic tribes |
|--------------|------------------|------------------|
| June .....   | 608              | 392              |
| July .....   | 594              | 406              |
| August ..... | 379              | 621              |

It is evident that the main change took place from July to August, at the end of the fishing season.

Turning now to the number of vertebrae (V.S.) a glance at Table 8 will give a survey of the distribution within the different tribes. It is noted that the average V.S. in both the Norwegian tribes is exactly the same, 57.20, and a little higher than in 1955 when it was 57.18 (NN) and 57.19 (NS).

Table 7. Composition of the catches by tribes, according to to fishing localities (‰)

| Tribes      | Areas |      |      |      |      |      |      |      |
|-------------|-------|------|------|------|------|------|------|------|
|             | I     | II   | III  | IV   | V    | VI   | VII  | VIII |
| NN .....    | —     | 132  | 325  | 312  | 446  | 553  | 599  | 500  |
| NS .....    | —     | 38   | 140  | 161  | 204  | 230  | 162  | 191  |
| ISPR .....  | 659   | 387  | 533  | 523  | 348  | 203  | 178  | 181  |
| ISUM .....  | 341   | 443  | 2    | 4    | 2    | 14   | 61   | 128  |
| Total ..... | 1000  | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |
| Number ...  | 208   | 235  | 431  | 813  | 643  | 492  | 197  | 94   |

Table 8. Total number of vertebrae (V.S.) by tribes

| V.S.         | NN    | NS    | ISPR  | ISUM  | ?     | Total |
|--------------|-------|-------|-------|-------|-------|-------|
| 60 .....     | —     | —     | I     | —     | —     | +     |
| 59 .....     | 21    | 10    | 27    | —     | 9     | 19    |
| 58 .....     | 290   | 312   | 320   | 167   | 251   | 292   |
| 57 .....     | 568   | 555   | 537   | 613   | 618   | 563   |
| 56 .....     | 113   | 119   | 109   | 211   | 119   | 120   |
| 55 .....     | 8     | 4     | 5     | 9     | 3     | 6     |
| 54 .....     | —     | —     | I     | —     | —     | +     |
| Total .....  | 1000  | 1000  | 1000  | 1000  | 1000  | 1000  |
| Number ..... | 1154  | 494   | 1249  | 227   | 367   | 3491  |
| M .....      | 57.20 | 57.20 | 57.26 | 56.94 | 57.14 | 57.20 |
| ± m .....    | 0.02  | 0.02  | 0.02  | 0.04  | 0.03  | 0.01  |

Table 9. Total number of vertebrae (V.S.) by maturity

| Stages      | Number | M     | ± m  |
|-------------|--------|-------|------|
| II .....    | 11     | 56.91 | 0.21 |
| III .....   | 1028   | 57.23 | 0.02 |
| IV .....    | 27     | 57.22 | 0.34 |
| V .....     | 7      | 56.86 | 0.25 |
| VII .....   | 25     | 57.08 | 0.12 |
| VIII .....  | 2383   | 57.19 | 0.01 |
| Total ..... | 3481   | 57.20 | 0.01 |

In the Icelandic tribes, on the other hand, the V. S. was higher in 1956 than in 1955, being 57.26 (57.22 in 1955) for the spring spawners and 56.94 (56.75) for the summer spawners. As is usual the Icelandic spring spawners show the highest and the summer spawners the lowest number of vertebrae.

In Table 9 the number of vertebrae is arranged according to stages of maturity. A glance at the table reveals clearly that the small summer spawning fraction is to be found in stage II, V, and VII and, to some extent, in VIII. The paramount part of the herring in stage VIII belongs, however, undoubtedly to the spring-spawning tribes.

In good agreement with the relatively early close of the season the advancement of maturity was somewhat behind the normal. The maturity factor proved to be 1.8 as against 2.0 in 1955, 1.7 in 1954, 2.3 in 1953, and 2.1 in 1952. The relative number of fish where the MF exceeded 5 (5% of the total weight) amounted to 1.0% only, the corresponding figures for 1955, 1954, 1953, and



Table 10. Returns of tagged herring in 1956

| Year<br>of tagging | Tagging locality |            |        | Total |
|--------------------|------------------|------------|--------|-------|
|                    | N. coast         | S.W. coast | Norway |       |
| 1948 .....         | 2                | —          | —      | 2     |
| 1949 .....         | —                | —          | 3      | 3     |
| 1950 .....         | 3                | —          | —      | 3     |
| 1951 .....         | 7                | —          | 4      | 11    |
| 1952 .....         | 73               | —          | 3      | 76    |
| 1953 .....         | 58               | 1          | 3      | 62    |
| 1954 .....         | 33               | —          | 2      | 35    |
| 1955 .....         | 51               | —          | 2      | 53    |
| 1956 .....         | 14               | —          | —      | 14    |
| ? .....            | 3                | —          | —      | 3     |
| Total .....        | 244              | 1          | 17     | 262   |

1952 being 3.5, 2.5, 8.9, and 3.4, respectively. If there is a relation between the MF value and the commencement of the next spawning season, spawning should have begun relatively early in 1954, relatively late in 1957.

Owing to a good supply of food in 1956 the index of intestinal fat was rather high (1.8), higher than in 1953 (1.7), 1954 (1.6), and 1955 (1.7).

In connexion with better yields, than through many previous years, it is extremely interesting to note that the number of returns of tagged herring was much higher than ever before. This appears clearly from Table 10.

The returns of herring tagged in Norway is of special interest as the number of recoveries in 1956 (17) exceeded the total of recovery of herring from Norway during 1948—1955 (15 tags altogether). In addition, three important facts were recorded in 1956, 1) one tag from the S.W.coast of Iceland was found at the north coast, 2) one tag from the S.W.coast was found in Norway and, 3) one tag from the north coast was found at the S.W. coast. The following figures indicate how many tags have been returned for each 100,000 hl. of herring processed in the north-coast factories during 1952—1956:—

|            | Returns from: |        |
|------------|---------------|--------|
|            | North coast   | Norway |
| 1952 ..... | 12            | 3      |
| 1953 ..... | 94            | 3      |
| 1954 ..... | 64            | 2      |
| 1955 ..... | 97            | 0      |
| 1956 ..... | 70            | 5      |

During July 8,443 purse-seine caught herrings were tagged off the north and east coast and 7,554 herrings, which had been caught in drift-nets, were tagged off the south-west coast. For tagging localities, see Figure 7.

Å. FRIÐRIKSSON

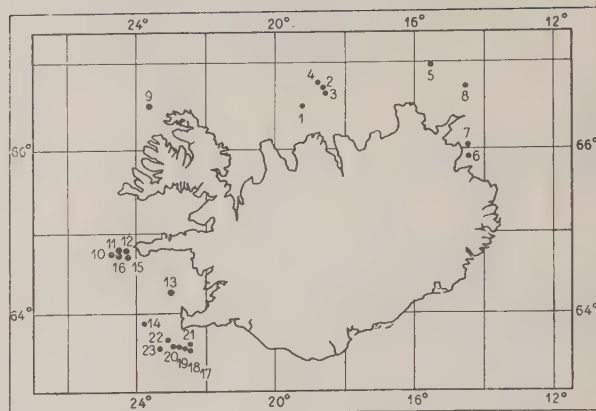


Figure 7. Localities of tagging in 1956.

### Norwegian Herring Investigations in the Norwegian Sea 1956

(Figures 8—9; Tables 12—14)

Apart from the fish-location survey during the approach to the Norwegian coast of the spawning shoals of herring in January, the R/V "G. O. Sars" made three cruises to the Norwegian Sea in 1956.

The first summer cruises (June—July), with Dr. EGGVIN in charge collected hydrographical data over a wide area of the Norwegian Sea in connexion with an Asdic survey for herring shoals. The cruise was co-ordinated with Danish and Icelandic investigations. The combined results were made known to the fishermen of the three participating countries.

On the second summer cruise (August—September with the writer in charge, additional hydrographical observations were made, and in connexion with the fish location some experimental fishing took place and samples were secured. Figure 8 shows the network of stations and locations of the fish registrations. The isotherms in 30 m. depth are also shown. Comparison with last year's (1955) results shows that the upper layers were warmer in 1956.

The data and positions of the fishing stations are given in Table 12.

It will be seen that except for St.4 the catches were small. The fat analyses revealed excellent quality.

The length and age distribution of the herring are given in Table 13 (station no. and sample no. correspond).



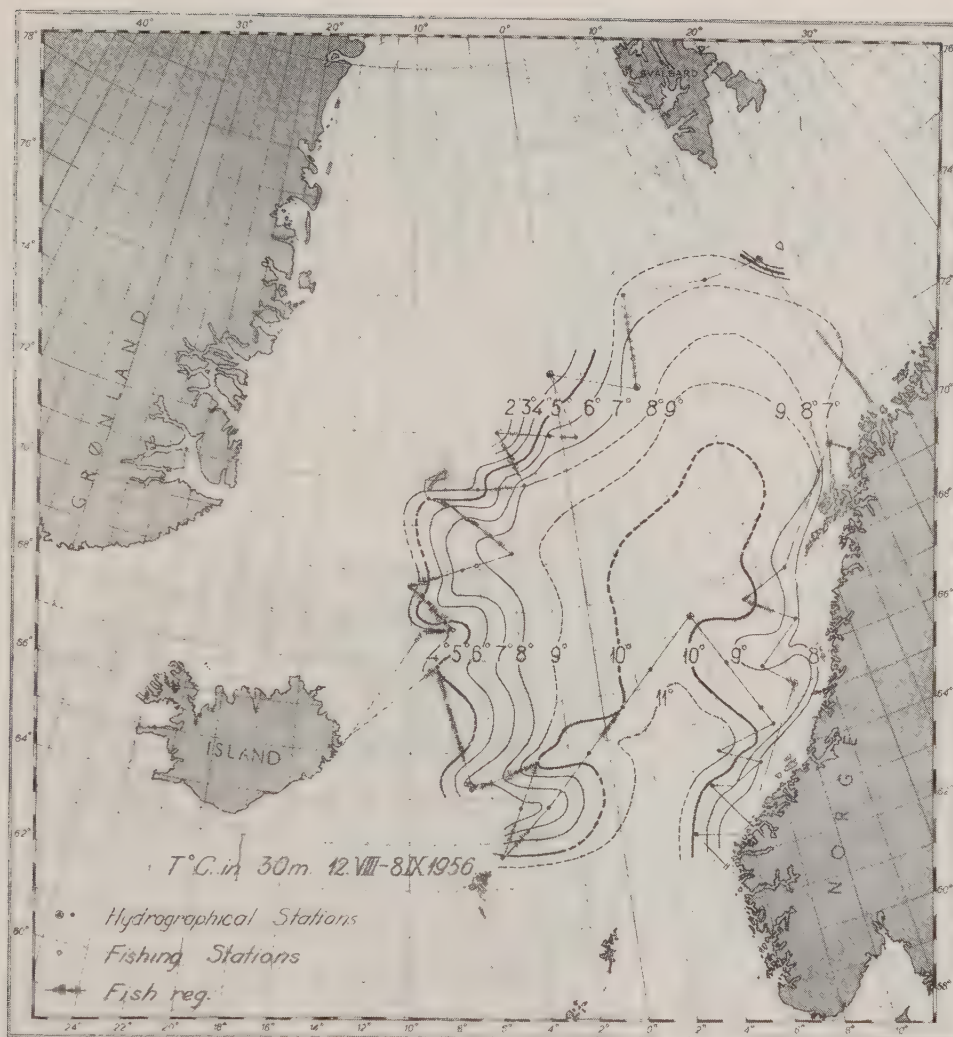


Figure 8

Table 12

| Station No. | Date August | Position N. W. | Number of nets | Catch (barrels) | Fat % | Sample No. |
|-------------|-------------|----------------|----------------|-----------------|-------|------------|
| 1           | 18.—19.     | 64°17' 07°02'  | 50             | ca. 7           | —     | 1          |
| 2           | 19.—20.     | 65°40' 07°55'  | 50             | „ 24            | —     | 2          |
| 3           | 20.—21.     | 66°04' 09°23'  | 50             | „ 5             | —     | 3          |
| 4           | 23.—24.     | 67°37' 07°48'  | 50             | „ 75            | 22.7  | 4          |
| 5           | 24.—25.     | 68°41' 09°18'  | 50             | „ 10            | 20.9  | 5          |
| 6           | 25.—26.     | 69°02' 06°09'  | 50             | „ 6             | 24.9  | 6          |
| 7           | 26.—27.     | 70°03' 06°20'  | 50             | „ 1             | 21.0  | 7          |
| 8           | 28.—29.     | 71°38' 04°00'  | 50             | „ 12            | 23.0  | 8          |
| 9           | 30.—31.     | 73°06' 05°33'  | 50             | 100 herring     | —     | Total      |

Table 14

| Maturity |     |     |   |     |
|----------|-----|-----|---|-----|
| II       | III | IV  | V | n   |
| 1        | 41  | 32  | 1 | 75  |
| I        | 69  | 29  | 1 | 100 |
| I        | 49  | 44  | — | 94  |
| —        | 47  | 53  | — | 100 |
| —        | 48  | 152 | — | 200 |
| —        | 46  | 54  | — | 100 |
| —        | 17  | 83  | — | 100 |
| —        | 14  | 85  | — | 99  |
| 3        | 331 | 532 | 2 | 868 |

From Table 13 will be seen that the herring were to a great extent large and old, the 1950 year-class being much less represented than in the winter herring. From this may be concluded that "G. O.

Sars" on this cruise (1956) did not traverse the greatest concentrations of herring.

The distributions of maturity stages are presented in Table 14.

Table 13

| Length<br>(cm.) | Sample nos. |     |    |     |     |     |     |     |   | Total | Age<br>(years) | Sample nos. |    |    |    |     |    |    |    |   | Total |
|-----------------|-------------|-----|----|-----|-----|-----|-----|-----|---|-------|----------------|-------------|----|----|----|-----|----|----|----|---|-------|
|                 | 1           | 2   | 3  | 4   | 5   | 6   | 8   | 9   | 1 |       |                | 2           | 3  | 4  | 5  | 6   | 8  | 9  |    |   |       |
| 26.0 .....      | —           | —   | —  | —   | —   | —   | —   | —   | — | —     | 1 .....        | —           | —  | —  | —  | —   | —  | —  | —  | — | —     |
| 5 .....         | 1           | —   | —  | —   | —   | —   | —   | —   | — | 1     | 2 .....        | —           | —  | —  | —  | —   | —  | —  | —  | — | —     |
| 27.0 .....      | —           | —   | —  | —   | —   | 3   | —   | 1   | — | 4     | 3 .....        | 2           | —  | —  | —  | —   | 1  | —  | —  | — | 3     |
| 5 .....         | 3           | —   | —  | —   | —   | 1   | —   | —   | — | 4     | 4 .....        | 4           | 5  | 1  | 1  | 6   | 5  | 2  | —  | — | 24    |
| 28.0 .....      | 6           | —   | —  | —   | —   | 12  | —   | 1   | — | 19    | 5 .....        | 4           | 4  | 2  | 4  | 11  | 5  | 4  | —  | — | 34    |
| 5 .....         | 1           | —   | —  | —   | —   | 8   | —   | —   | — | 9     | 6 .....        | 28          | 16 | 9  | 38 | 80  | 72 | 30 | 11 | — | 284   |
| 29.0 .....      | 3           | 1   | —  | —   | 1   | 20  | —   | —   | — | 25    | 7 .....        | 2           | 2  | 1  | 3  | 7   | 1  | 2  | 2  | — | 20    |
| 5 .....         | 1           | —   | —  | —   | —   | 3   | —   | —   | — | 4     | 8 .....        | 5           | 2  | 7  | 5  | 17  | 3  | 7  | 3  | — | 49    |
| 30.0 .....      | —           | —   | —  | —   | —   | 2   | 3   | 1   | — | 6     | 9 .....        | 4           | 7  | 6  | 4  | 15  | 1  | 4  | 6  | — | 47    |
| 5 .....         | —           | —   | —  | —   | —   | —   | —   | —   | — | —     | 10 .....       | 2           | 13 | 9  | 5  | 14  | —  | 9  | 2  | — | 54    |
| 31.0 .....      | 4           | 1   | —  | 1   | —   | 4   | —   | 1   | — | 11    | 11 .....       | 6           | 9  | 4  | 10 | 15  | 1  | 12 | 10 | — | 69    |
| 5 .....         | 1           | —   | —  | —   | 4   | 2   | 3   | —   | — | 10    | 12 .....       | 3           | 9  | 10 | 7  | 9   | —  | 6  | 3  | — | 52    |
| 32.0 .....      | 4           | 3   | 1  | 5   | 14  | 7   | 12  | —   | — | 46    | 13 .....       | 1           | 3  | 7  | 6  | 2   | —  | 6  | 2  | — | 27    |
| 5 .....         | 2           | 2   | 2  | 3   | 15  | 9   | 8   | 4   | — | 45    | 14 .....       | —           | —  | —  | 1  | —   | —  | —  | 2  | — | 3     |
| 33.0 .....      | 5           | 11  | 4  | 17  | 33  | 17  | 6   | 3   | — | 96    | 15 .....       | 2           | 1  | 3  | 1  | 3   | —  | 4  | 4  | — | 18    |
| 5 .....         | 3           | 1   | 3  | 6   | 17  | 6   | 3   | 3   | — | 42    | 16 .....       | 2           | 4  | 4  | 1  | —   | 1  | 1  | 8  | — | 21    |
| 34.0 .....      | 13          | 12  | 5  | 11  | 27  | 1   | 10  | 3   | — | 82    | 17 .....       | 1           | 4  | 5  | 1  | 1   | —  | 3  | 5  | — | 20    |
| 5 .....         | 1           | 1   | 3  | 7   | 13  | 2   | 4   | 1   | — | 32    | 18 .....       | 3           | 1  | 1  | —  | 1   | —  | 2  | 2  | — | 10    |
| 35.0 .....      | 4           | 15  | 11 | 15  | 21  | —   | 9   | 7   | — | 82    | 19 .....       | 1           | 2  | 3  | —  | —   | —  | 1  | —  | — | 8     |
| 5 .....         | 8           | 9   | 9  | 2   | 10  | 1   | 7   | 16  | — | 62    | 20 .....       | 1           | 1  | 1  | —  | —   | —  | —  | 2  | — | 5     |
| 36.0 .....      | 11          | 25  | 29 | 18  | 24  | 2   | 21  | 28  | — | 158   | 21 .....       | —           | —  | 2  | —  | —   | —  | —  | —  | — | 2     |
| 5 .....         | 7           | 7   | 5  | 6   | 10  | —   | 5   | 20  | — | 60    | Total .....    | 72          | 88 | 77 | 82 | 181 | 90 | 93 | 62 | — | 750   |
| 37.0 .....      | 3           | 5   | 15 | 6   | 10  | —   | 5   | 10  | — | 54    |                |             |    |    |    |     |    |    |    |   |       |
| 5 .....         | —           | 3   | 2  | 2   | —   | —   | 3   | 1   | — | 11    |                |             |    |    |    |     |    |    |    |   |       |
| 38.0 .....      | —           | 3   | 6  | 1   | 1   | —   | 1   | —   | — | 12    |                |             |    |    |    |     |    |    |    |   |       |
| 5 .....         | —           | —   | —  | —   | —   | —   | —   | —   | — | —     |                |             |    |    |    |     |    |    |    |   |       |
| 39.0 .....      | —           | 1   | —  | —   | —   | —   | —   | —   | — | 1     |                |             |    |    |    |     |    |    |    |   |       |
| Total .....     | 81          | 100 | 95 | 100 | 200 | 100 | 100 | 100 | — | 876   |                |             |    |    |    |     |    |    |    |   |       |

During December a cruise was undertaken with "G. O. Sars" in the Norwegian Sea under the leadership of O. J. ØSTVEDT. The purpose of the cruise was to locate the Atlanto-Scandian herring

Comparison with the 1955 investigations reveals that the maturity is more advanced in 1956 than in the year before. This concurs with the higher sea temperatures.

During December a cruise was undertaken with "G. O. Sars" in the Norwegian Sea under the leadership of O. J. ØSTVEDT. The purpose of the cruise was to locate the Atlanto-Scandian herring approaching the Norwegian spawning grounds, and to take hydrographical observations. Figure 9 shows the temperature at a depth of 30 m. The hatched area indicate where herring was observed. No samples were taken owing to unusually adverse weather.

OLAF AASEN

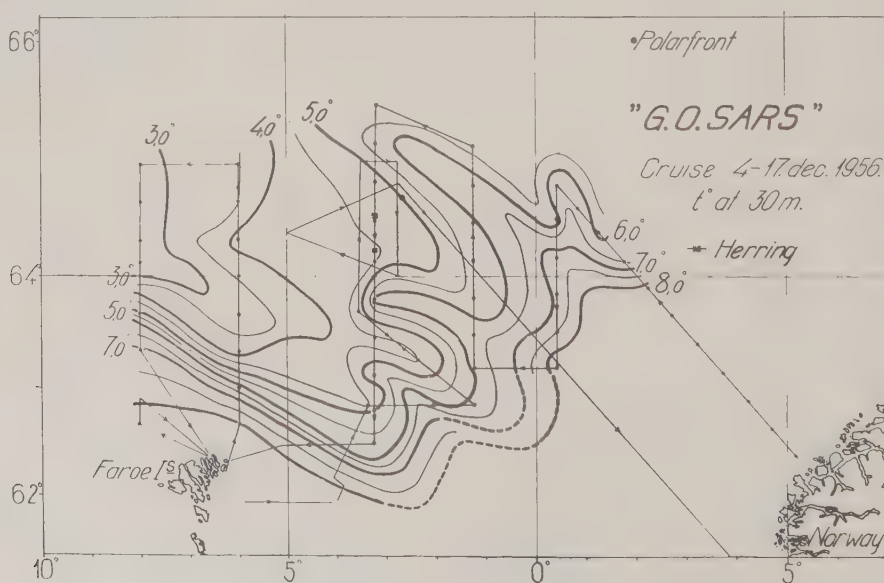


Figure 9.

### **Occurrence of Herring North and North-East of the Faroes**

The research vessel "Dana" did not carry out any survey of the area north and north-east of the Faroes in June 1956 owing to the extensive programme of work in the North Sea. The ordinary survey was carried out by the research vessels "G. O. Sars" and "Ægir", and the Faroe vessel "Ternan"; the last one surveyed the area between 1°W. and 8°30' W. Long; north to 65°N. Lat. The hydrographical conditions were rather normal and the distribution of herring, according to echo-soundings, showed a normal pattern also. The boundary between Atlantic water and the

East Icelandic Current was however farther north than in 1955.

In April and September the fishing inspection vessel "Thetis" collected some hydrographical data and echo-soundings on short cruises north of the Faroes.

About 125 vessels from the Faroes carried out drift-net fishing; the results were best in the second half of September and early October (after 10. October the weather was extremely unfavourable). A total of about 185,000 barrels of herring was taken. Information service to the fishing fleet was conducted as in previous years.

Å. VEDEL TÅNING

## **B. Near Northern Seas**

### **YOUNG STAGES**

#### **Larvae in the Southern North Sea 1955 and 1956**

During the cruises with "Anton Dohrn" and "Gauss" in March 1955 (cf. Ann. Biol., XII) in the Southern Bight and the south-eastern North Sea and a cruise with "Anton Dohrn" in April 1956 in the German Bight some hauls with the Petersen young-fish trawl and a ring trawl were made. In March 1955 only small numbers of herring larvae were found. In the Flemish Bight larvae of small size (about 15 mm.) predominated. In consequence of the hydrographical situation these larvae, which presumably were hatched in the eastern Channel in January ("jüngere Downs-larven"), had not been transported farther towards north-east into the south-eastern North Sea. On the Oyster Ground larger larvae of about 20—25 mm. ("ältere Downs-larven") were abundant. A small number of the "ältere Downs-larven" may have been mixed with the Dogger Bank larvae (25 to 30 mm.) in the samples from the German Bight.

In the coastal waters the length distribution was bimodal with one peak between 25 and 30 mm. and another of about 40 mm. The largest larvae are supposed to have hatched on the spawning grounds in the north-western North Sea. The length distribution in the catches from the coastal waters of the inner German Bight is rather similar to that of the samples from the Jade estuary in 1952<sup>1)</sup>. In the Jade estuary 1955 the catches were very poor.

In April 1956 herring larvae seemed to have disappeared from the offshore area. Only at some stations near the east Friesian coast a mixture of larvae of medium and large size was abundant.

G. HEMPEL

<sup>1)</sup> A. BÜCKMANN & G. HEMPEL, 1957: "Untersuchungen an der Heringslarvenbevölkerung der Innenjade." Helgol. Wiss. Meeresunters., 6.

## COMMERCIAL FISH

## Length, Age, and Spawning Groups of the Norwegian Winter Herring 1956

(Tables 15-17)

The total landings of winter herring in the season 1956 amounted to 12.3 mill. hl., 8.7 mill. hl. being taken by purse-seine and 3.6 mill. hl. by other gear, mainly drift-net. The season lasted from 14. January to 28. March, in all 64 fishing days. The average catch per fishing day was 192,517 hl. compared to 142,203 hl. per fishing day in 1955 (total catch 10.3 mill. hl.) and 190,000 hl. in 1954 (total catch 11.7 mill. hl.).

During the season 37 samples, totalling 6,700 herrings, were secured. Table 15 shows the size

Table 15.

Length composition of Norwegian winter herring ( $^{0}/_{00}$ )  
A) Stages IV—VIII; B) Total (including stages I—III and herring with scales not fit for age determination)

| cm.          | A           |           | B           |           |
|--------------|-------------|-----------|-------------|-----------|
|              | Purse-seine | Drift-net | Purse-seine | Drift-net |
| 23.0 .....   | —           | —         | 0.5         | —         |
| .5 .....     | —           | —         | 0.5         | —         |
| 24.0 .....   | —           | —         | 1           | —         |
| .5 .....     | —           | —         | 0.5         | —         |
| 25.0 .....   | —           | —         | 2           | —         |
| .5 .....     | —           | —         | 3           | —         |
| 26.0 .....   | 1           | —         | 5           | —         |
| .5 .....     | 1           | —         | 6           | —         |
| 27.0 .....   | 3           | —         | 8           | —         |
| .5 .....     | 2           | 1         | 6           | 1         |
| 28.0 .....   | 3           | 2         | 8           | 1         |
| .5 .....     | 11          | 2         | 15          | 1         |
| 29.0 .....   | 32          | 11        | 39          | 10        |
| .5 .....     | 36          | 13        | 38          | 13        |
| 30.0 .....   | 72          | 40        | 71          | 41        |
| .5 .....     | 65          | 35        | 62          | 34        |
| 31.0 .....   | 123         | 104       | 112         | 102       |
| .5 .....     | 106         | 106       | 97          | 101       |
| 32.0 .....   | 140         | 172       | 128         | 164       |
| .5 .....     | 82          | 86        | 75          | 80        |
| 33.0 .....   | 59          | 91        | 54          | 88        |
| .5 .....     | 30          | 30        | 29          | 29        |
| 34.0 .....   | 31          | 41        | 31          | 39        |
| .5 .....     | 25          | 25        | 25          | 24        |
| 35.0 .....   | 50          | 55        | 49          | 56        |
| .5 .....     | 33          | 47        | 35          | 53        |
| 36.0 .....   | 52          | 58        | 54          | 69        |
| .5 .....     | 19          | 33        | 21          | 35        |
| 37.0 .....   | 16          | 31        | 16          | 38        |
| .5 .....     | 4           | 10        | 5           | 13        |
| 38.0 .....   | 3           | 6         | 3           | 7         |
| .5 .....     | 1           | 1         | 0.5         | 1         |
| 39.0 .....   | —           | —         | —           | —         |
| Total .....  | 1000        | 1000      | 1000        | 1000      |
| Number ..... | 4662        | 1208      | 5287        | 1349      |

Table 16. Age composition of Norwegian winter herring, maturity—stages IV—VIII

| Age                                  | Purse-seine |        |       | Drift-net |        |       |
|--------------------------------------|-------------|--------|-------|-----------|--------|-------|
|                                      | N.type      | S.type | Total | N.type    | S.type | Total |
| 3 .....                              | —           | 5      | 2     | —         | 7      | 3     |
| 4 .....                              | 2           | 130    | 60    | —         | 59     | 28    |
| 5 .....                              | 9           | 134    | 66    | 9         | 188    | 94    |
| 6 .....                              | 641         | 522    | 587   | 610       | 492    | 554   |
| 7 .....                              | 19          | 31     | 25    | 20        | 28     | 24    |
| 8 .....                              | 57          | 20     | 40    | 42        | 25     | 34    |
| 9 .....                              | 52          | 32     | 43    | 41        | 49     | 45    |
| 10 .....                             | 14          | 27     | 19    | 9         | 26     | 17    |
| 11 .....                             | 34          | 34     | 34    | 33        | 39     | 36    |
| 12 .....                             | 48          | 24     | 37    | 47        | 42     | 45    |
| 13 .....                             | 21          | 15     | 19    | 19        | 12     | 16    |
| 14 .....                             | 8           | 9      | 9     | 8         | 11     | 9     |
| 15 .....                             | 12          | 6      | 9     | 28        | —      | 15    |
| 16 .....                             | 18          | 5      | 12    | 23        | 7      | 16    |
| 17 .....                             | 20          | 3      | 12    | 52        | 9      | 31    |
| 18 .....                             | 22          | 1      | 13    | 29        | 4      | 17    |
| 19 .....                             | 8           | 1      | 5     | 14        | 2      | 8     |
| 20 .....                             | 9           | —      | 5     | 11        | —      | 6     |
| 21 .....                             | 4           | 1      | 2     | 5         | —      | 2     |
| 22 .....                             | 2           | —      | 1     | —         | —      | —     |
| Total .....                          | 1000        | 1000   | 1000  | 1000      | 1000   | 1000  |
| Number ...                           | 2545        | 2117   | 4662  | 638       | 570    | 1208  |
| Scales not fit for age determination |             |        | 332   |           |        | 135   |
| Immature (stages I—III)              |             |        | 300   |           |        | 6     |

composition of the samples taken from the purse-seine and the drift-net landings. It is seen that the drift-net herring differed in size from the purse-seine herring, fish smaller than 31.0 cm. being less numerous in the drift-net samples.

The age composition of the winter herring is shown in Table 16. The herring has been separated into northern and southern types, according to the scale pattern. The southern type has a much faster growth during the first years of life and reaches maturity at a lower age than the slow-growing northern type. The younger herrings 3, 4, and 5 years old are therefore more numerous in the southern type than in the northern type. The 1950 year-class, which since 1954 has dominated the catch of winter herring (Ann. Biol., XII (1955)), in 1956 made out more than 550 $^{0}/_{00}$ . This year-class was in 1956 not fully recruited to the spawning stock (a large part of the northern type usually reaches maturity at an age of 7 years) and it will probably be even more predominant in 1957.

In Table 17 is shown the distribution of spawning groups. The spawning groups I, II, and III, which were entirely dominated by the 1950 year-class constituted more than 700 $^{0}/_{00}$  of the spawning



Table 17.

Distribution of spawning groups of Norwegian winter herring

| Spawning groups | Purse-seine | Drift-net |
|-----------------|-------------|-----------|
| I .....         | 363         | 264       |
| II .....        | 130         | 206       |
| III .....       | 271         | 254       |
| IV .....        | 35          | 33        |
| V .....         | 22          | 20        |
| VI .....        | 22          | 24        |
| VII .....       | 33          | 38        |
| VIII .....      | 39          | 43        |
| IX .....        | 19          | 26        |
| X .....         | 15          | 21        |
| XI .....        | 13          | 19        |
| XII .....       | 16          | 21        |
| XIII .....      | 14          | 20        |
| XIV .....       | 5           | 8         |
| XV .....        | 1           | 3         |
| XVI .....       | 1           | —         |
| XVII .....      | 1           | —         |
| Total .....     | 1000        | 1000      |
| Number .....    | 4623        | 1177      |

stock. Due to the selectivity of the drift-net, the first-time spawners were more numerous in the purse-seine samples than in the drift-net samples. Herring spawning for the 17th time were present in the purse-seine samples.

O. J. ØSTVEDT

### Norwegian Tagging Experiments in 1956

(Figure 10; Tables 18–19)

Shedding tests were carried out during the large-herring season in 1956 (cp. Ann. Biol. 1955), but the experiments failed. A total of 4998 large herring were tagged, using internal steel tags (Table 18).

The land-seine fishery for herring was extremely poor during the spring in 1956 and it was impossible to secure live fish for tagging. After the close of the spring-herring fishery 6,299 "forfangstsild", i.e., recruit spawners mixed with fat herring, were tagged at three localities between Bergen and Ålesund (Table 18).

The fat herring taggings (7,550) were carried out in August at six localities between Nordmøre and Lofoten (Table 18). In the "forfangstsild" experiments both internal and external tags were used as well as a combination of the two.

Figure 10 shows the long-distance migrations in 1956 of the "forfangstsild" and fat herring tagged at Langevåg and Sandviksbukt respectively. There is a general migration in northern direction of the immature herring in summer and southwards during the autumn.

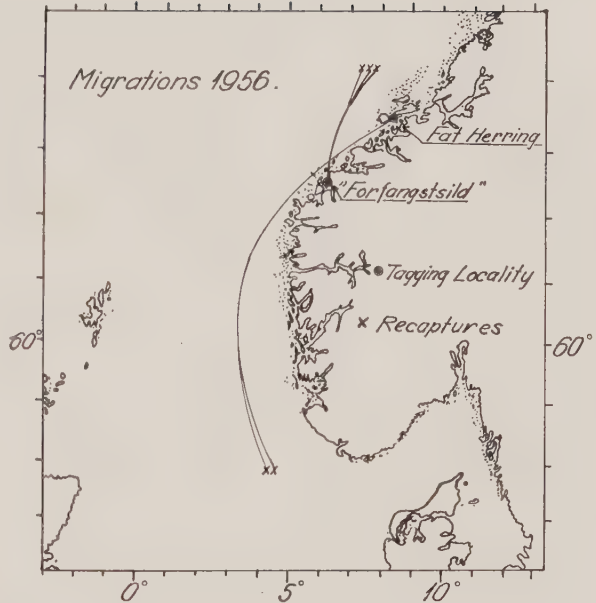


Figure 10. Long-distance migrations in 1956 of "forfangstsild" (tagged 17. IV.—5. V.) and fat herring (tagged 14.—30. VIII).

Table 18. Large herring, "forfangstsild" and fat herring taggings in 1956

| Large herring                                     |               | Number of liberations<br>by type of tag |                                                  |
|---------------------------------------------------|---------------|-----------------------------------------|--------------------------------------------------|
| Area                                              | Date          |                                         |                                                  |
| Batalden<br>(W. of Florø) ..                      | 17.-22. II.   | 4998                                    | (internal)                                       |
| "Forfangstsild"                                   |               |                                         |                                                  |
| Dyrøy<br>(W. of Bergen) .                         | 17.-19. IV.   | 1750                                    | 1550 internal<br>200 external                    |
| Flister (S. of Stad)                              | 23.-26. IV.   | 2200                                    |                                                  |
|                                                   |               |                                         | 2000 internal<br>200 external                    |
| Langevåg<br>(W. of Ålesund)                       | 30. IV.-5. V. | 2349                                    | 2149 internal<br>100 external<br>100 int. & ext. |
|                                                   |               |                                         |                                                  |
| Fat herring                                       |               |                                         |                                                  |
| Sandviksbukt<br>(Nordmøre) ...                    | 14.-15. VIII. | 2100                                    | 2000 internal<br>100 external                    |
| Olden (Trøndelag)                                 | 17. VIII.     | 500                                     |                                                  |
| Øyvåg (Rørvik) ..                                 | 21. VIII.     | 1300                                    | (internal)<br>1200 internal<br>100 external      |
| Nord Sjøna<br>(N. of Sand-<br>nessjøen) . . . . . | 24. VIII.     | 1200                                    | 1100 internal<br>100 external                    |
|                                                   |               |                                         |                                                  |
| Sørfjord<br>(S. of Bodø) ...                      | 27. VIII.     | 1300                                    | 1200 internal<br>100 external                    |
|                                                   |               |                                         |                                                  |
| Engan (N. of Bodø)                                | 29.-30. VIII. | 1150                                    | 1100 internal<br>50 external                     |

Table 19. Number of returns from reduction plants with tested magnets for the different experiments and returns per million hectolitres in ‰ (in brackets)

| Year of tagging | Category | Numbers tagged | Year of recapture |           |           |            |            |            |            |
|-----------------|----------|----------------|-------------------|-----------|-----------|------------|------------|------------|------------|
|                 |          |                | 1950              | 1951      | 1952      | 1953       | 1954       | 1955       | 1956       |
| 1948            | SH       | 6,018          | 14 (1.30)         | 12 (0.74) | 23 (0.87) | 15 (0.74)  | 15 (0.43)  | 7 (0.35)   | 9 (0.29)   |
| 1948            | OH       | 7,475          | 9 (0.67)          | 7 (0.35)  | 9 (0.28)  | 9 (0.36)   | 12 (0.28)  | 1 (0.03)   | 1 (0.03)   |
| 1949            | SH       | 8,261          | 26 (1.75)         | 22 (0.98) | 25 (0.68) | 17 (0.61)  | 44 (0.92)  | 16 (0.41)  | 21 (0.50)  |
| 1950            | LH       | 9,085          | —                 | 14 (0.57) | 14 (0.35) | 10 (0.33)  | 16 (0.31)  | 9 (0.21)   | 10 (0.22)  |
| 1950            | SH       | 11,215         | —                 | 9 (0.30)  | 9 (0.18)  | 8 (0.21)   | 12 (0.19)  | 7 (0.13)   | 12 (0.21)  |
| 1950            | OH       | 1,827          | —                 | 10 (2.03) | 16 (2.00) | 13 (2.10)  | 13 (1.23)  | 8 (0.95)   | 6 (0.64)   |
| 1951            | LH       | 5,998          | —                 | —         | 23 (0.87) | 22 (1.08)  | 27 (0.78)  | 18 (0.65)  | 12 (0.39)  |
| 1951            | SH       | 9,986          | —                 | —         | 63 (1.41) | 60 (1.77)  | 68 (1.18)  | 57 (1.24)  | 27 (0.53)  |
| 1951            | OH       | 5,076          | —                 | —         | 55 (2.48) | 54 (3.14)  | 84 (2.86)  | 31 (1.32)  | 29 (1.11)  |
| 1952            | LH       | 10,295         | —                 | —         | —         | 18 (0.52)  | 26 (0.44)  | 14 (0.29)  | 12 (0.23)  |
| 1952            | SH       | 10,763         | —                 | —         | —         | 73 (2.00)  | 107 (1.72) | 137 (2.76) | 103 (1.87) |
| 1952            | OH       | 17,308         | —                 | —         | —         | 246 (4.19) | 328 (3.27) | 116 (1.45) | 103 (1.16) |
| 1953            | LH       | 10,080         | —                 | —         | —         | —          | 19 (0.33)  | 8 (0.17)   | 9 (0.18)   |
| 1953            | SH       | 10,046         | —                 | —         | —         | —          | 37 (0.64)  | 47 (1.01)  | 32 (0.62)  |
| 1953            | OH       | 10,181         | —                 | —         | —         | —          | 274 (4.66) | 105 (2.24) | 102 (1.96) |
| 1954            | LH       | 10,042         | —                 | —         | —         | —          | —          | 24 (0.51)  | 18 (0.35)  |
| 1954            | SH       | 10,291         | —                 | —         | —         | —          | —          | 86 (1.81)  | 74 (1.40)  |
| 1954            | OH       | 8,783          | —                 | —         | —         | —          | —          | 121 (2.93) | 74 (1.05)  |
| 1955            | LH       | 10,045         | —                 | —         | —         | —          | —          | —          | 91 (1.77)  |
| 1955            | SH       | 9,087          | —                 | —         | —         | —          | —          | —          | 27 (0.58)  |
| 1955            | OH       | 12,063         | —                 | —         | —         | —          | —          | —          | 140 (2.27) |

LH = Large herring

SH = Spring herring

OH = Open ocean and north coast herring

In Table 19 is given a summary of the recoveries from reduction plants with tested magnets for the different experiments; the within-season recoveries are not included. It will be noticed that the large herring tagged in 1955 yielded more returns in 1956 than did the spring herring tagged the same year. Except for the tagging in 1950 the large herring have given the lowest percentage recoveries.

OLAV DRAGESUND

### 0- and I-Group, Scotland 1955—56

(Tables 20 and 21)

The 'halflin' fishery in the upper reaches of the Moray Firth was very successful during the winter of 1955—56 and the total catch was the highest on record. Landings of 'halflins' from the ring-net

fishery in the upper reaches of the Firth of Forth (based on a mixed stock of sprats, 0-group and 'halflin' herring) were however even lower than in the previous year. Landing and crude effort statistics for these fisheries for the years 1951—56 are given in Table 20.

The size ranges, mean lengths, and mean Vert. S. of samples of 0- and I-group herring taken from the commercial fisheries and from sampling by research vessels are given in Table 21. The vertebral counts indicate that spring-spawned fish formed only a small part of the stocks of 0- and I-group herring in 1956. The spring-spawned fish which were present in strength among the 0-group herring in 1954—55 (Ann. Biol., XII) were not prominent among the I-group herring in 1955—56.

G. MCPHERSON

Table 20. Statistics of 'halflin' fisheries 1951—56

|                                       | Season           |                 |                  |                  |                 |
|---------------------------------------|------------------|-----------------|------------------|------------------|-----------------|
|                                       | 1951-52          | 1952-53         | 1953-54          | 1954-55          | 1955-56         |
| Upper Moray Firth                     |                  |                 |                  |                  |                 |
| Duration of season                    | 29.9.51-29.3.52  | 13.9.52-21.3.53 | 12.9.53-20.2.54  | 18.9.54-26.3.55  | 1.10.55-31.3.56 |
| Number of landings                    | 783              | 1,631           | 2,654            | 1,715            | 2,989           |
| Total catch (crans)                   | 19,066           | 38,885          | 61,773           | 25,263           | 61,945          |
| Catch/landing (crans)                 | 24.4             | 23.8            | 23.3             | 14.7             | 20.7            |
| Upper Firth of Forth                  |                  |                 |                  |                  |                 |
| Duration of season                    | 18.12.51-18.4.52 | 4.10.52-21.3.53 | 26.12.53-10.4.54 | 18.10.54-23.3.55 | 24.9.55-31.3.56 |
| Greatest number of boats engaged      | 45               | 31              | 29               | 22               | 16              |
| Estimated catch of 'halflins' (crans) | 7,911            | 2,513           | 13,554           | 786              | 379             |

**Table 21. Length and mean Vert. S. of 0- and I-group herring caught in the inshore waters off the Scottish east coast in 1955-56**

(Numbers in brackets)

| Locality                           | Date                    | Range<br>(cm.) | Mean<br>length (cm.) | Mean<br>Vert. S. |
|------------------------------------|-------------------------|----------------|----------------------|------------------|
| Autumn 1954 and spring 1955 broods |                         |                |                      |                  |
| Firth of Forth                     | Feb. 1956 <sup>1)</sup> | 7-14           | 9.04 (67)            | 56.54 (63)       |
|                                    | Feb. 1956 <sup>2)</sup> | 7-14           | 10.02 (130)          | 56.57 (127)      |
| Aberdeen Bay                       | Oct. 1955 <sup>1)</sup> | 6-14           | 8.89 (157)           | 56.53 (157)      |
| Autumn 1953 to spring 1954 broods  |                         |                |                      |                  |
| Firth of Forth                     | Nov. 1955 <sup>3)</sup> | 15-23          | 18.84 (390)          | 56.54 (246)      |
| Inverness Firth                    | Nov. 1955               | 18-23          | 20.48 (197)          | 56.52 (197)      |
|                                    | Dec. 1955               | 17-24          | 20.39 (302)          | 56.59 (250)      |
|                                    | Feb. 1956               | 18-24          | 21.09 (180)          | 56.57 (180)      |
|                                    | Mar. 1956               | 19-23          | 21.46 (197)          | 56.68 (197)      |

<sup>1)</sup> Samples caught by beach-seine.<sup>2)</sup> Samples caught by boom net.<sup>3)</sup> Samples caught by ring-net.

All others caught by drift-net.

**Scottish Fisheries 1956**

(Figures 11-15; Charts 1-12; Tables 22-31)

**A. North Sea****Commercial Landings****Drift-net**

During 1956 drift-net fishing in the North Sea was carried out from the following Scottish ports: Aberdeen (April to mid-September), Peterhead (March to September), Fraserburgh (mid-April to September), Lerwick (May to mid-August), and Wick (June and July).

Drifters from Aberdeen, Peterhead, and Fraserburgh fished in the north-eastern North Sea in March and April. The Aberdeen fleet continued fishing in the north-eastern North Sea in the first

half of May but gradually moved their grounds westwards and southwards till by the end of May they were fishing in the north-western North Sea. At the beginning of May the Peterhead and Fraserburgh fleets moved their operations to the Shetland and Bressay grounds where Lerwick boats had started a successful fishery. The main drift-net fishery on the grounds within an 80-mile radius from Peterhead and Fraserburgh was late in starting and was not in full swing until the end of May. In June good catches were landed from all the customary grounds in the north-western North Sea but in the first half of July the fishery became very poor on the Buchan grounds and many boats from these ports fished on the grounds off Shetland and Orkney where good catches were made. The Buchan fishery recovered again in late July and August when it became centred on the spawning grounds off the Scottish east coast.

The landing and crude effort statistics for the drift-net fisheries for 1956 and the previous three years are given in Table 22, and detailed statistics of catch and effort for each month from April to September are shown in Charts 1-12. Charts 1-6 give the total number of hauls per month in each 10-mile square (10' latitude by 20' longitude) and Charts 7-12 the corresponding average catch per 100 nets per haul for the same squares.

Landings at Fraserburgh and Peterhead in 1956 fell to little more than half of the 1955 total due, partly, to a further reduction in the fishing effort and partly to the period of poor fishing on the Buchan grounds in July. The landing per arrival figures for all the ports suggest that the average density of the available stocks for the season as a whole was at about the same level as in the previous three years.

**Table 22. East coast and Shetland landings, 1953-1956**

|                             | Drift-net        |         |         |        | Average landing per arrival <sup>1)</sup> (crans) |       |       |       |
|-----------------------------|------------------|---------|---------|--------|---------------------------------------------------|-------|-------|-------|
|                             | Landings (crans) |         |         |        | Arrivals                                          |       |       |       |
|                             | 1953             | 1954    | 1955    | 1956   | 1953                                              | 1954  | 1955  | 1956  |
| Fraserburgh ...             | 213,285          | 147,817 | 171,462 | 84,831 | 9,790                                             | 6,630 | 5,740 | 3,811 |
| Peterhead .....             | 124,762          | 87,218  | 89,454  | 54,337 | 4,899                                             | 3,570 | 2,984 | 1,720 |
| Lerwick .....               | 15,666           | 23,382  | 43,216  | 42,019 | 1,345                                             | 1,664 | 1,733 | 1,966 |
| Wick .....                  | 5,345            | 4,894   | 2,614   | 2,325  | 387                                               | 242   | 74    | 57    |
| Aberdeen .....              | 72,217           | 61,499  | 73,041  | 58,996 | 1,183                                             | 1,000 | 959   | 858   |
|                             | Trawl            |         |         |        | Hours fishing                                     |       |       |       |
|                             | Landings (crans) |         |         |        | Landings per 100 hours (crans)                    |       |       |       |
|                             | 1953             | 1954    | 1955    | 1956   | 1953                                              | 1954  | 1955  | 1956  |
| North-eastern North-Sea ... | —                | 681     | 948     | 1,254  | —                                                 | 172   | 121   | 310   |
| Fladen .....                | 8,950            | 3,869   | 1,268   | 2,721  | 3,382                                             | 1,502 | 311   | 1,269 |
| Gut and southwards ..       | 8,976            | 12,057  | 10,912  | 4,625  | 2,391                                             | 2,871 | 3,090 | 1,850 |

<sup>1)</sup> These figures are not adjusted to standard number of nets per haul. Each arrival at Aberdeen represents on average two hauls. Each arrival at other drift-net ports usually only one haul.



Number of Hauls

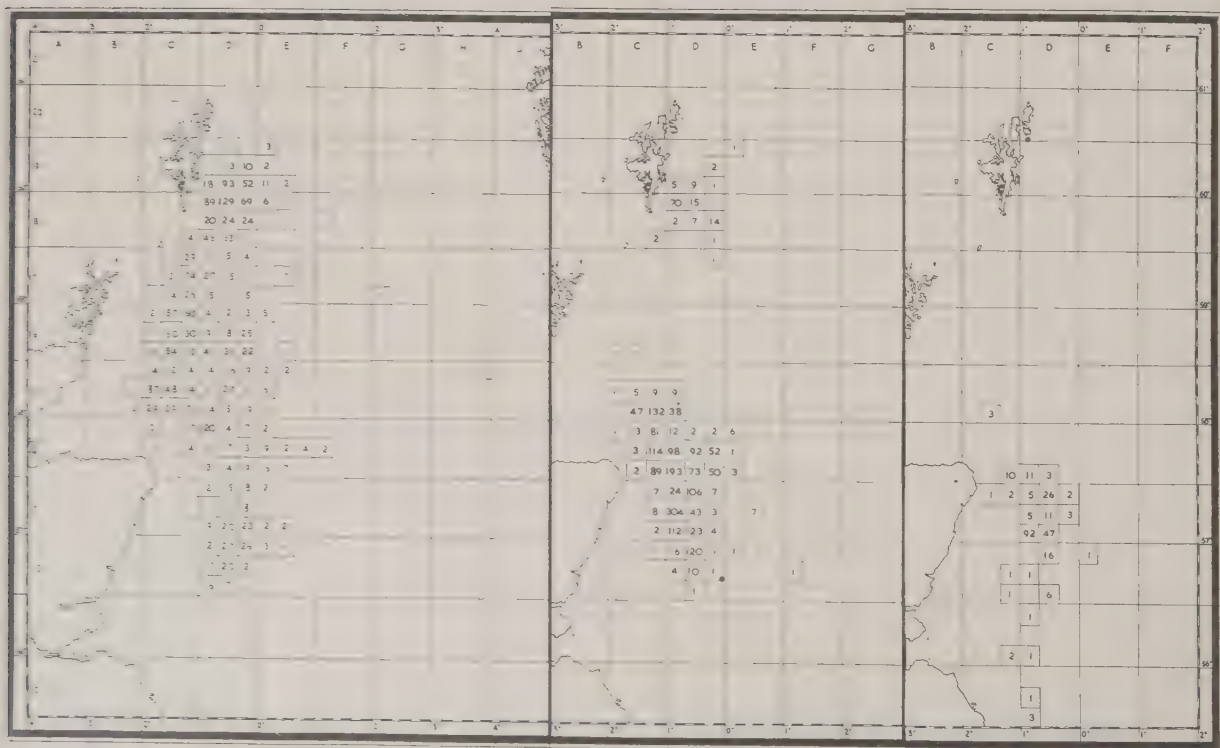


Charts 1—3.

April

May

June



Charts 4—6.

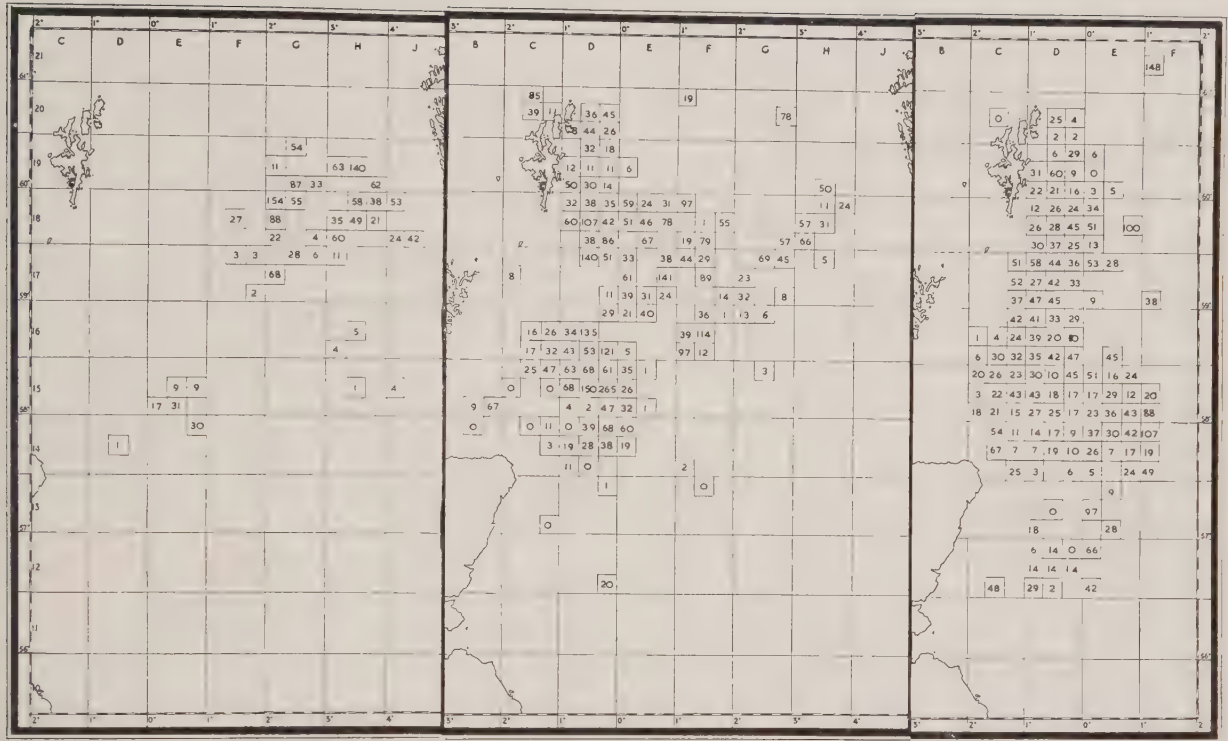
July

August

September



Average Catch



Charts 7—9.

April

May

June



Charts 10—12.

July

August

September

# Trawl

Landings of trawled herring were made at Aberdeen during February and April 1956 by Swedish vessels, fishing in the north-eastern North Sea, mainly with 'pair' trawls, and further landings were made in the period August—November principally by Swedish trawlers from the Fladen and Gut grounds.

The landings and crude effort statistics for these trawl fisheries are given in Table 22. These show that the density of the available stock was much lower on the Fladen and Gut grounds in 1956 than in the three previous years. The shift of effort from the Fladen to the Gut which had been so marked since 1952 was reversed in 1956.

## Length, Age, and Racial Composition of Samples

Sampling of the drift-net landings at Aberdeen, Fraserburgh, Peterhead, and Lerwick in 1956 was conducted on the same lines as in 1955 (Ann. Biol., XII).

### North-eastern North Sea

The length and age compositions of the samples taken in the north-eastern North Sea between April and June 1956 are shown in Figure 11 and the maturity and Vert. S. data are given in Table 23.

These data show that the populations sampled consisted of a mixture of spring and autumn spawners. As in previous years (Ann. Biol., XII) the autumn spawners consisted of a wide range of age-groups, and the spring spawners only of the younger age-groups. This is confirmed by the results of the analyses of otolith characters which are given in Table 24. These data show that the spring spawners predominated in April when fishing was centred in the eastern extremity of the North Sea but that autumn spawners predominated in May and June when the centres of fishing moved gradually westwards towards the north-western regions. In all months, the autumn spawners were represented chiefly by the abundant 1953 brood.

### North-western North Sea

Daily samples were taken from the landings at Aberdeen, Fraserburgh, Peterhead, and Lerwick by drifters fishing in the north-western North Sea

## NORTH-EASTERN NORTH SEA 1956.

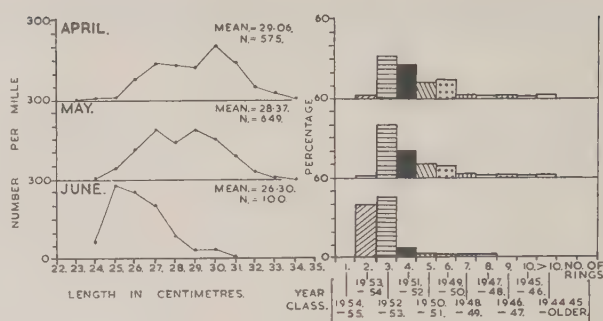


Figure 11. Length and age compositions of north-eastern North Sea drift-net samples April—June 1956. (Length frequencies unsmoothed).

between May and September. The statistical squares sampled in each month were as follows:—

|       | Lerwick  |      |             |      |           |      |
|-------|----------|------|-------------|------|-----------|------|
| May   | D 20     | C 20 | D 19        | C 19 | D 18      |      |
| June  | D 20     | C 20 | E 19        | D 19 | D 18      |      |
| July  |          |      | E 19        | D 19 | D 18      |      |
| Aug.  |          |      |             |      | D 18      | C 18 |
|       | Aberdeen |      | Fraserburgh |      | Peterhead |      |
| May   | E 17     | D 16 | C 16        | D 15 | B 15      | D 15 |
|       | E 15     | D 15 |             | D 14 |           | D 14 |
| June  | D 17     | D 16 | D 15        | D 16 | C 16      | D 15 |
|       | E 14     |      |             | D 15 | C 15      | E 14 |
|       | E 12     | D 12 | D 11        |      |           | D 14 |
| July  | D 18     | D 17 | C 17        | C 17 | D 16      | C 16 |
|       | D 16     | E 15 | C 15        | D 15 | C 15      |      |
|       | E 14     | D 14 |             | D 13 |           | D 15 |
|       | D 12     | D 11 |             |      |           | D 14 |
| Aug.  | E 13     | D 13 | D 12        | D 15 | D 14      | C 14 |
|       | D 11     | C 11 | C 10        | D 13 | C 13      | D 13 |
| Sept. | D 13     | D 12 | C 11        | D 14 | D 13      | D 12 |

It is evident that, as in 1955, the Aberdeen boats generally fished over a wider area than the Fraserburgh and Peterhead fleets (Ann. Biol., XII). The Fraserburgh fleet also fished generally further to the north than in 1955 but the Peterhead fleet again concentrated on the local Moray Firth grounds.

The length and age compositions of these samples are shown in Figure 12 and the maturity and Vert. S. data are given in Table 25.

These data show that in the period May to July the stock fished by the Peterhead fleet had a

Table 23. Maturity and racial characters, north-eastern North Sea, 1956

|       | A. Percentage maturity |      |      |     |   |     |              | B. Vert. S.                      |    |    |     |     |    |    |
|-------|------------------------|------|------|-----|---|-----|--------------|----------------------------------|----|----|-----|-----|----|----|
|       | (All age-groups)       |      |      |     |   |     |              | (Actual numbers, all age-groups) |    |    |     |     |    |    |
|       | Maturity stage         |      |      |     |   |     |              | Number of vertebrae              |    |    |     |     |    |    |
|       | I                      | II   | III  | IV  | V | VI  | VII & VII-II | Numbers                          | 54 | 55 | 56  | 57  | 58 | 59 |
| April | 7.7                    | 5.4  | 1.2  | 0.2 | — | 8.7 | 76.9         | 575                              | —  | 12 | 158 | 326 | 65 | 4  |
| May   | 11.2                   | 22.2 | 0.6  | —   | — | 0.5 | 65.5         | 649                              | 1  | 21 | 242 | 317 | 53 | 1  |
| June  | 24.0                   | 45.0 | 11.0 | 1.0 | — | —   | 19.0         | 100                              | —  | 5  | 39  | 45  | 8  | 1  |

Mean

Table 24. Age composition of spring and autumn spawners in north-eastern North Sea between April and June, 1956

| Year-class                        | Winter-rings | Spring group |      |     |      |      |      | Year-class     | Winter-rings | Autumn group |      |     |      |      |      | Total sample |          |
|-----------------------------------|--------------|--------------|------|-----|------|------|------|----------------|--------------|--------------|------|-----|------|------|------|--------------|----------|
|                                   |              | April        |      | May |      | June |      |                |              | April        |      | May |      | June |      | % Spring     | % Autumn |
|                                   |              | No.          | %    | No. | %    | No.  | %    |                |              | No.          | %    | No. | %    | No.  | %    |              |          |
| 1954                              | 2            | 7            | 2.3  | 7   | 3.8  | 16   | 76.1 | 1953           | 2            | 9            | 3.5  | 19  | 4.1  | 23   | 29.1 | 32.9         | 67.1     |
| 1953                              | 3            | 101          | 32.5 | 59  | 32.2 | 4    | 19.0 | 1952           | 3            | 94           | 36.1 | 203 | 44.1 | 43   | 54.4 | 32.5         | 67.5     |
| 1952                              | 4            | 88           | 28.3 | 71  | 38.7 | —    | —    | 1951           | 4            | 48           | 18.4 | 83  | 17.9 | 9    | 11.3 | 53.2         | 46.8     |
| 1951                              | 5            | 43           | 13.8 | 21  | 11.4 | —    | —    | 1950           | 5            | 25           | 9.6  | 46  | 9.9  | 2    | 2.5  | 46.7         | 53.3     |
| 1950                              | 6            | 63           | 20.3 | 23  | 12.5 | 1    | 4.7  | 1949           | 6            | 27           | 10.4 | 39  | 8.4  | —    | —    | 56.9         | 43.1     |
| 1949                              | 7            | 5            | 1.6  | 1   | 0.5  | —    | —    | 1948           | 7            | 10           | 3.8  | 22  | 4.8  | 1    | 1.3  | 15.3         | 84.7     |
| 1948                              | 8            | 3            | 0.9  | 1   | 0.5  | —    | —    | 1947           | 8            | 7            | 2.7  | 15  | 3.2  | 1    | 1.3  | 14.8         | 85.2     |
| 1947                              | 9            | —            | —    | —   | —    | —    | —    | 1946           | 9            | 10           | 3.8  | 13  | 2.8  | —    | —    | —            | 100      |
| 1946                              | 10           | —            | —    | —   | —    | —    | —    | 1945           | 10           | 8            | 3.1  | 5   | 0.1  | —    | —    | —            | 100      |
| 1945 and older                    | >10          | 1            | —    | —   | —    | —    | —    | 1944 and older | >10          | 22           | 8.4  | 17  | 3.7  | —    | —    | —            | 100      |
| Total number of otoliths examined |              | 311          |      | 183 |      | 21   |      |                |              | 260          |      | 462 |      | 79   |      | 39.1         | 60.9     |

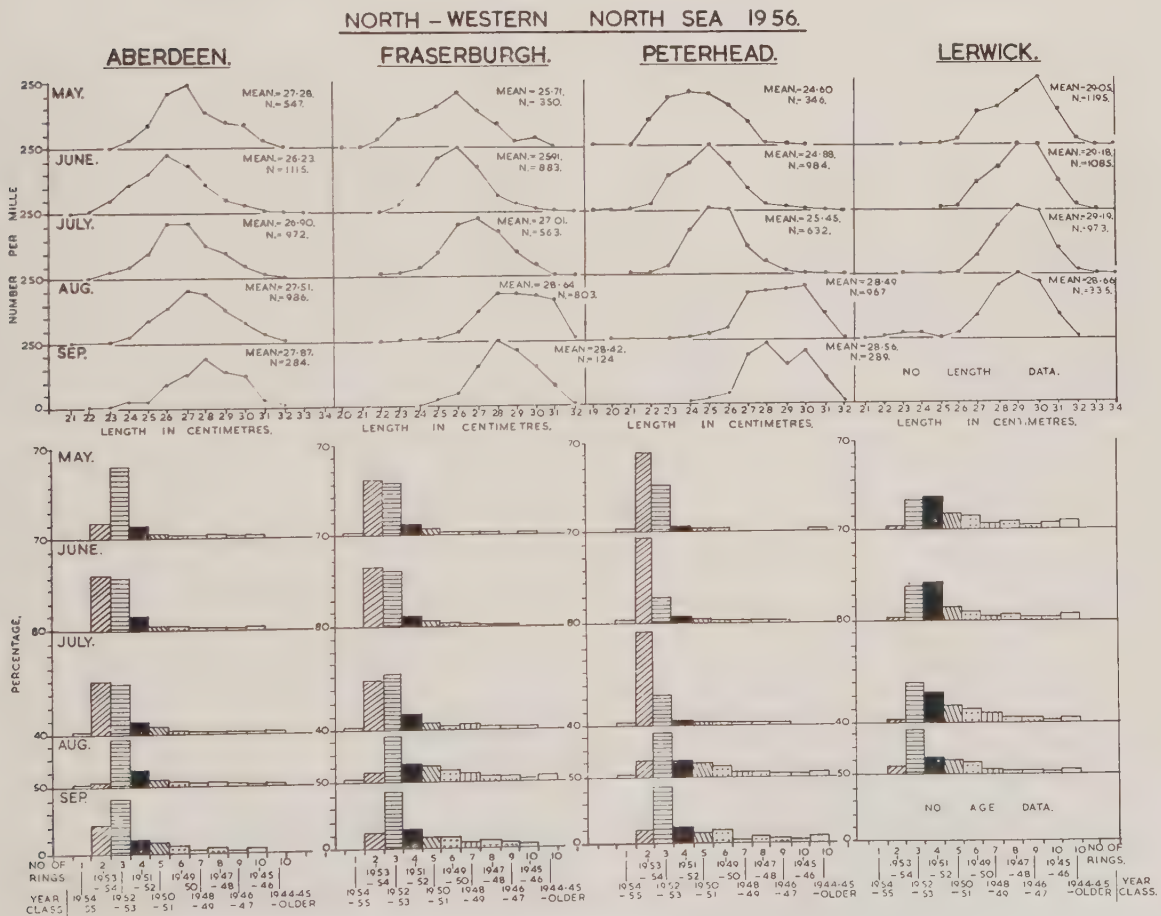


Figure 12. Length and age compositions of north-western North Sea drift-net samples May–September 1956.  
(Length frequencies unsmoothed).



Table 25. Maturity and racial characters, north-western North Sea, 1956

|             | A. Percentage maturity |      |      |      |      |      |              | B. Vert. S.                      |    |    |     |     |    |    |    |       |  |  |
|-------------|------------------------|------|------|------|------|------|--------------|----------------------------------|----|----|-----|-----|----|----|----|-------|--|--|
|             | (All age-groups)       |      |      |      |      |      |              | (Actual numbers, all age-groups) |    |    |     |     |    |    |    |       |  |  |
|             | Maturity stage         |      |      |      |      |      |              | Number of vertebrae              |    |    |     |     |    |    |    |       |  |  |
|             | I                      | II   | III  | IV   | V    | VI   | VII & VII-II | Numbers                          | 54 | 55 | 56  | 57  | 58 | 59 | 60 | Mean  |  |  |
| Aberdeen    |                        |      |      |      |      |      |              |                                  |    |    |     |     |    |    |    |       |  |  |
| May ....    | 15.4                   | 52.3 | 0.9  | —    | —    | —    | 31.5         | 547                              | —  | 8  | 160 | 182 | 30 | 1  | —  | 56.62 |  |  |
| June ....   | 17.8                   | 48.8 | 15.6 | 1.9  | 0.1  | 0.1  | 15.8         | 1115                             | —  | 31 | 362 | 439 | 51 | 1  | —  | 56.58 |  |  |
| July ....   | 13.9                   | 14.6 | 36.8 | 13.1 | 10.2 | 2.6  | 8.9          | 971                              | 1  | 37 | 413 | 421 | 75 | 1  | —  | 56.56 |  |  |
| August ..   | 1.3                    | 1.5  | 8.9  | 12.0 | 15.2 | 44.3 | 16.7         | 986                              | —  | 27 | 456 | 441 | 34 | —  | —  | 56.50 |  |  |
| September   | 0.7                    | 1.4  | 4.2  | 6.0  | 6.3  | 32.4 | 48.9         | 284                              | —  | 8  | 143 | 115 | 12 | —  | —  | 56.47 |  |  |
| Fraserburgh |                        |      |      |      |      |      |              |                                  |    |    |     |     |    |    |    |       |  |  |
| May ....    | 35.4                   | 39.7 | 0.9  | —    | —    | 0.6  | 23.4         | 350                              | —  | 7  | 126 | 181 | 28 | —  | —  | 56.67 |  |  |
| June ....   | 23.4                   | 49.0 | 11.9 | 1.3  | 0.1  | —    | 14.3         | 883                              | —  | 13 | 207 | 267 | 37 | 2  | —  | 56.63 |  |  |
| July ....   | 9.2                    | 16.5 | 33.0 | 22.0 | 12.6 | 0.7  | 5.9          | 563                              | —  | 7  | 89  | 108 | 15 | 1  | —  | 56.61 |  |  |
| August ..   | 2.1                    | 2.4  | 3.9  | 12.3 | 28.8 | 31.8 | 18.8         | 803                              | —  | 9  | 161 | 173 | 20 | —  | —  | 56.56 |  |  |
| September   | —                      | 0.8  | 2.4  | 10.5 | 16.9 | 40.3 | 29.0         | 124                              | —  | 7  | 62  | 50  | 3  | —  | —  | 56.40 |  |  |
| Peterhead   |                        |      |      |      |      |      |              |                                  |    |    |     |     |    |    |    |       |  |  |
| May ....    | 48.3                   | 38.4 | 1.5  | —    | —    | —    | 11.9         | 346                              | —  | 2  | 75  | 105 | 14 | 1  | —  | 56.68 |  |  |
| June ....   | 36.1                   | 41.7 | 9.4  | 1.1  | —    | —    | 11.8         | 984                              | —  | 10 | 173 | 220 | 27 | —  | —  | 56.61 |  |  |
| July ....   | 18.5                   | 22.3 | 30.4 | 18.4 | 5.7  | 0.2  | 4.6          | 632                              | —  | 11 | 170 | 173 | 24 | —  | 1  | 56.56 |  |  |
| August ..   | 1.1                    | 1.9  | 5.1  | 10.3 | 22.9 | 36.6 | 22.0         | 967                              | —  | 32 | 323 | 328 | 34 | 2  | —  | 56.51 |  |  |
| September   | —                      | 0.4  | 1.4  | 2.1  | 8.3  | 54.7 | 33.2         | 289                              | —  | 2  | 39  | 45  | 3  | —  | —  | 56.55 |  |  |
| Lerwick     |                        |      |      |      |      |      |              |                                  |    |    |     |     |    |    |    |       |  |  |
| May ....    | 3.4                    | 25.1 | 0.3  | 0.3  | —    | 1.1  | 69.9         | 1195                             | —  | 27 | 466 | 593 | 83 | 4  | —  | 56.63 |  |  |
| June ....   | 3.2                    | 38.1 | 10.9 | 2.6  | 0.8  | 0.3  | 44.0         | 1085                             | 2  | 24 | 376 | 581 | 85 | 3  | —  | 56.68 |  |  |
| July ....   | 1.6                    | 17.8 | 22.7 | 15.6 | 13.4 | 3.2  | 25.6         | 973                              | —  | 18 | 348 | 489 | 83 | 3  | —  | 56.69 |  |  |
| August ..   | 6.3                    | 12.8 | 10.2 | 9.3  | 12.2 | 7.5  | 41.8         | 335                              | 1  | 8  | 122 | 176 | 22 | 1  | —  | 56.65 |  |  |

different age structure from that fished by the Aberdeen and Fraserburgh fleets. The 2-year-old and 3-year-old broods (2 and 3 winter-rings) were the dominant age-groups providing between 77% and 93% of the samples at each port but at Peterhead the two-ringers outnumbered the three-ringers by about three to one while at Aberdeen and Fraserburgh the two broods were of almost equal strength. This difference is due to the greater concentration of the Peterhead fleet on the more southerly grounds. This is illustrated by the data in Table 26 which gives the percentage age composition of the combined Aberdeen, Fraserburgh, and Peterhead samples for May to July taken north of 58°15' N. and the percentage age composition of the samples from south of that line. It can be seen that south of 58°15' N. the two-ringers outnumber the three-ringers by almost three to one (as in the Peterhead samples in Fig. 12) but to the north the three-ringers are twice as numerous as the two-ringers. In Shetland waters two-ringers made only a small contribution to the catches, much less than in 1955. It is evident that the difference in age structure of the catches at the three ports is due to age stratification of the stock in the north-western North Sea.

In August the age compositions of the Aberdeen, Fraserburgh, and Peterhead catches underwent the same alteration as in previous years (Ann. Biol., IX—XII) when many of the recruit brood moved

out of the area and were replaced by older fish moving on to the spawning grounds.

It is evident from the distribution and density of the younger age-groups in the samples from the Buchan and Shetland ports that the 2-ringed autumn-spawned 1954 recruit brood was less abundant than the 1953 brood, which dominated the catches in the northern part of the fishing region in the pre-spawning period, and also the spawning shoals in August and September.

As in previous years, the average age of the Shetland samples was higher than on the Buchan grounds. The stock there, like that in the north-eastern North Sea, was composed of a mixture of autumn spawners ranging in age between 2 and 14 years, and of spring spawners between 2 and 6 years. Preliminary results from the analysis of otoliths from these samples now under way, indicate the same general age composition of both racial components as shown in the north-eastern North Sea in Table 24.

The length for age data collected in 1956 from the north-western North Sea show that the high values recorded for successive age-groups in recent years and presented in the previous volume (Ann. Biol., XII) were maintained in 1956. The mean lengths for age-group II to V taken at Fraserburgh and Peterhead in the years 1954—1956 were as follows:—



## TRAWLED HERRING, 1956.

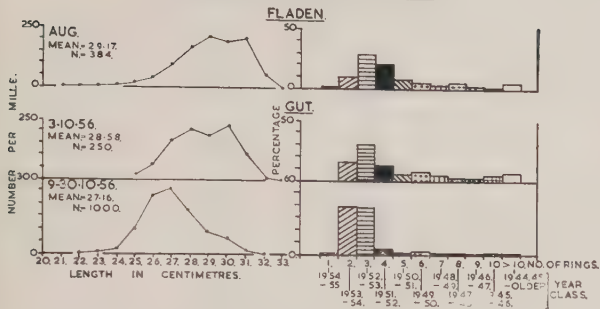


Figure 13. Length and age compositions of trawl samples August—October 1956. (Length frequencies unsmoothed).

| Age<br>(winter-rings) | Mean Length (cm.) |       |       |
|-----------------------|-------------------|-------|-------|
|                       | 1954              | 1955  | 1956  |
| 2                     | 24.69             | 24.18 | 24.76 |
| 3                     | 26.92             | 26.81 | 26.97 |
| 4                     | 28.12             | 28.68 | 28.36 |
| 5                     | 28.71             | 29.34 | 29.43 |

## Fladen and Gut

Samples were taken in August from research vessel catches on the Fladen Ground and in October from the landings by Swedish vessels from the Gut. The length and age compositions of these samples are shown in Figure 13 and the maturity and Vert. S. data are given in Table 27.

The age compositions of the Fladen sample and of the Gut sample of 3. Oct. 1956 closely resemble the age compositions of the spawning concentrations on the Scottish east coast in August—September but the later Gut samples show an influx of two-ringers mostly at maturity stage VII—II. The vertebral counts of the Gut samples show that they are composed principally of autumn-spawned fish.

## B. West Coast

## Minch

Herring fishing in the Minch in 1956 was conducted, as in previous years, by drift-net and ring-net. Catches from the North Minch were landed mainly at the ports of Stornoway, Ullapool, and Gairloch and from the South Minch at Mallaig and Oban.

As in 1955, the fishery in the spring for spawning herring along the north-west mainland coast yielded very poor catches. However, the summer drift-net fishery in the north showed a considerable improvement over 1955, due mainly to large catches of adolescent spring spawners which were obtained during July.

The landing statistics for the North and South Minches are given in Table 28. These statistics show that the overall yield from the drift-net and ring-net fisheries in the North and South Minches was similar to that obtained in 1955. The total landings and landings per unit of effort by drift-net in the South Minch were considerably higher than in 1955. Ring-net landings, however, in both North and South Minches were lower than in the previous year.

Length and age composition data from North and South Minches are given in Figures 14 and 15, and maturities and mean Vert. S. are presented in Tables 29 and 30. The North Minch data are from drift-net samples and the South Minch data from drift-net (February and March) and ring-net (January, October, and November) samples.

The age composition data shows that 2-ringed fish, which were new recruits to the stock, began to appear in considerable numbers in April and predominated in the catches throughout the rest of the year. Racial data (vertebral counts and otolith

Table 26. Percentage age composition of Aberdeen, Fraserburgh, and Peterhead samples May—July, 1956

| Area of capture       | Age (winter-rings) |      |      |      |     |     |     |     |     |     |     | Total |
|-----------------------|--------------------|------|------|------|-----|-----|-----|-----|-----|-----|-----|-------|
|                       | 1                  | 2    | 3    | 4    | 5   | 6   | 7   | 8   | 9   | 10  | >10 |       |
| North of 58°15'N. . . | —                  | 24.5 | 50.6 | 12.3 | 4.2 | 3.4 | 1.7 | 1.1 | 1.0 | 0.6 | 0.8 | 2834  |
| South of 58°15'N. . . | 0.7                | 66.0 | 24.5 | 4.3  | 2.0 | 0.7 | 0.5 | 0.5 | 0.5 | 0.2 | 0.1 | 3396  |
| Total . . . . .       | 0.4                | 47.1 | 36.4 | 7.9  | 3.0 | 1.9 | 1.0 | 0.8 | 0.7 | 0.4 | 0.5 | 6230  |

Table 27. Maturity and racial characters, Fladen and Gut, 1956

|                   | A. Percentage maturity<br>(All age-groups) |     |     |      |      |      |              | B. Vert. S.<br>(Actual numbers, all age-groups) |         |    |     |     |    |    |       |
|-------------------|--------------------------------------------|-----|-----|------|------|------|--------------|-------------------------------------------------|---------|----|-----|-----|----|----|-------|
|                   | Maturity stage                             |     |     |      |      |      |              | Number of vertebrae                             |         |    |     |     |    |    |       |
|                   | I                                          | II  | III | IV   | V    | VI   | VII & VII-II | Numbers                                         | 54      | 55 | 56  | 57  | 58 | 59 | Mean  |
|                   | Fladen                                     |     |     |      |      |      |              |                                                 |         |    |     |     |    |    |       |
| August . . . . .  | 10.4                                       | 8.5 | 4.4 | 10.9 | 26.3 | 9.1  | 30.1         | 384                                             | No Data |    |     |     |    |    |       |
|                   | Gut                                        |     |     |      |      |      |              |                                                 |         |    |     |     |    |    |       |
| 3. Oct. . . . .   | 1.6                                        | 2.0 | 4.0 | 3.6  | 8.4  | 11.6 | 68.8         | 250                                             | —       | 6  | 117 | 103 | 18 | 1  | 56.56 |
| 9.—30. Oct. . . . | 5.7                                        | 3.2 | 1.1 | 1.2  | 0.2  | 1.5  | 87.1         | 1000                                            | 1       | 40 | 445 | 436 | 56 | —  | 56.52 |

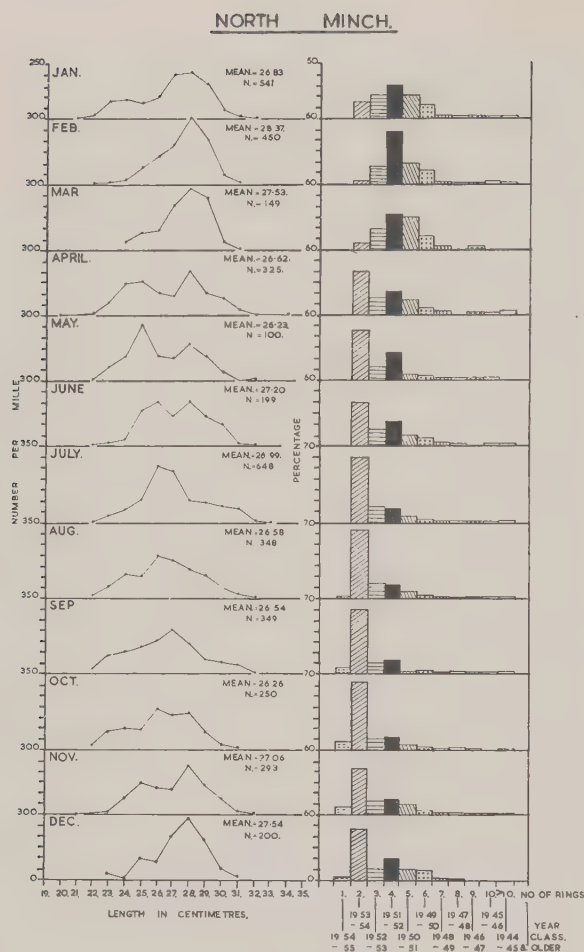


Figure 14. Length and age compositions of North Minch drift-net samples January–December 1956. (Length frequencies unsmoothed).

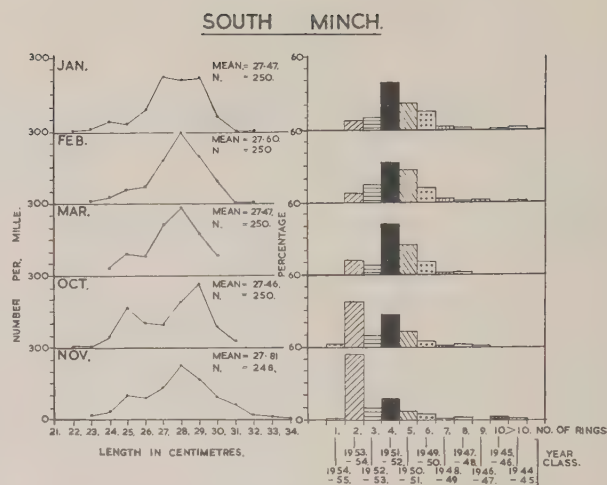


Figure 15. Length and age compositions of South Minch drift-net (February and March) and ring-net (January, October, and November) samples 1956. (Length frequencies unsmoothed).

types) indicated that these new recruits to the stock were mainly spring spawners.

In the North Minch it is evident from the racial data that spring-spawning fish formed a considerably higher percentage of the stocks than in previous years.

### C. Tagging

In 1956 tagging was again carried out mainly from commercial fishing vessels using Lea and Scottish combination tags attached by toggles or

Table 28. West coast herring landings

|          | North Minch      |                    |                             | South Minch      |                    |                             |
|----------|------------------|--------------------|-----------------------------|------------------|--------------------|-----------------------------|
|          | Drift-net        |                    |                             | Drift-net        |                    |                             |
|          | Landings (crans) | Number of arrivals | Landing per arrival (crans) | Landings (crans) | Number of arrivals | Landing per arrival (crans) |
| 1953     | 181,254          | 8,030              | 22.6                        | 15,915           | 442                | 36.0                        |
| 1954     | 183,951          | 7,928              | 23.2                        | 17,128           | 455                | 37.6                        |
| 1955     | 79,557           | 4,710              | 16.9                        | 21,605           | 633                | 34.1                        |
| 1956     | 80,727           | 4,423              | 18.3                        | 39,010           | 971                | 40.2                        |
| Ring-net |                  |                    |                             |                  |                    |                             |
| 1953     | 23,508           | 1,074              | 21.9                        | 52,451           | 1,069              | 49.1                        |
| 1954     | 37,488           | 1,142              | 32.8                        | 68,629           | 1,568              | 43.1                        |
| 1955     | 34,781           | 875                | 39.7                        | 55,241           | 1,201              | 46.0                        |
| 1956     | 21,762           | 774                | 28.1                        | 50,782           | 1,125              | 45.2                        |

Table 29. Maturity and racial characters — North Minch

| A. Percentage maturity (all age-groups) |       |       |       |       |       |       |       |       |       |       |       |       |
|-----------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Maturity stage                          | Jan.  | Feb.  | Mar.  | Apr.  | May   | June  | July  | Aug.  | Sep.  | Oct.  | Nov.  | Dec.  |
| I .....                                 | 13.68 | 2.00  | 5.37  | 45.54 | 44.00 | 40.20 | 49.07 | 31.32 | 37.53 | 32.40 | 15.02 | 6.50  |
| II .....                                | 2.77  | 1.78  | 0.67  | 1.85  | 35.00 | 30.15 | 21.60 | 10.34 | 16.33 | 17.20 | 11.60 | 13.50 |
| III .....                               | 3.14  | 8.44  | 6.71  | —     | —     | 9.05  | 12.96 | 13.22 | 5.73  | 7.20  | 5.80  | 22.00 |
| IV .....                                | 2.22  | 16.22 | 2.68  | —     | —     | 7.04  | 7.56  | 18.97 | 2.87  | 0.40  | 3.07  | 4.00  |
| V .....                                 | 1.11  | 12.89 | —     | —     | —     | 0.50  | 2.78  | 16.38 | 1.72  | —     | —     | 1.00  |
| VI .....                                | —     | 14.67 | —     | 0.31  | —     | —     | 0.46  | —     | 1.72  | 0.82  | 0.34  | —     |
| VII .....                               | 5.18  | 4.89  | 0.67  | 1.23  | 1.00  | 1.00  | —     | 1.15  | 2.01  | 1.60  | 0.68  | 0.50  |
| VII—II .....                            | 71.90 | 39.11 | 83.89 | 51.08 | 20.00 | 12.06 | 5.56  | 8.62  | 32.09 | 40.40 | 63.48 | 52.50 |
| Number .....                            | 541   | 450   | 149   | 325   | 100   | 199   | 648   | 348   | 349   | 250   | 293   | 200   |

B. Mean Vert. S. for each maturity stage (all age-groups)

| (Nos. in brackets are no. of fish) |                |                |                |               |               |                |                |                |                |                |                |                |
|------------------------------------|----------------|----------------|----------------|---------------|---------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| I .....                            | 56.81<br>(73)  | 56.88<br>(8)   | 57.11<br>(8)   | 57.11<br>(9)  | 56.77<br>(43) | 56.84<br>(79)  | 56.98<br>(308) | 56.91<br>(108) | 56.91<br>(129) | 56.71<br>(79)  | 56.68<br>(44)  | 57.18<br>(11)  |
| II .....                           | 56.60<br>(15)  | 57.14<br>(7)   | 58.00<br>(1)   | 56.20<br>(5)  | 56.44<br>(34) | 56.48<br>(60)  | 56.74<br>(136) | 56.80<br>(35)  | 57.00<br>(57)  | 57.14<br>(43)  | 56.94<br>(34)  | 56.93<br>(27)  |
| III .....                          | 56.71<br>(17)  | 56.75<br>(36)  | 56.89<br>(9)   | —             | —             | 56.35<br>(17)  | 56.49<br>(80)  | 56.45<br>(44)  | 56.53<br>(19)  | 57.00<br>(18)  | 57.06<br>(17)  | 56.95<br>(44)  |
| IV .....                           | 56.92<br>(12)  | 57.10<br>(70)  | 56.75<br>(4)   | —             | —             | 56.21<br>(14)  | 56.52<br>(48)  | 56.42<br>(65)  | 56.90<br>(10)  | 57.00<br>(1)   | —              | 56.86<br>(8)   |
| V .....                            | 56.83<br>(6)   | 57.02<br>(58)  | —              | —             | —             | 58.00<br>(1)   | 56.72<br>(18)  | 56.54<br>(56)  | 56.83<br>(6)   | —              | —              | 58.00<br>(2)   |
| VI .....                           | —              | 56.92<br>(66)  | —              | —             | —             | —              | 57.00<br>(2)   | —              | 56.80<br>(5)   | 56.50<br>(2)   | 57.00<br>(1)   | —              |
| VII .....                          | 56.46<br>(28)  | 56.68<br>(22)  | 57.00<br>(1)   | 58.00<br>(1)  | 55.00<br>(1)  | 56.00<br>(2)   | —              | 57.25<br>(4)   | 56.14<br>(7)   | 56.00<br>(4)   | 57.00<br>(2)   | 57.00<br>(1)   |
| VII—II .....                       | 56.46<br>(384) | 56.57<br>(174) | 56.61<br>(124) | 56.36<br>(53) | 56.75<br>(20) | 56.35<br>(23)  | 56.81<br>(36)  | 56.93<br>(30)  | 56.54<br>(111) | 56.49<br>(99)  | 56.48<br>(186) | 56.51<br>(105) |
| Overall mean .....                 | 56.54<br>(535) | 56.81<br>(441) | 56.67<br>(147) | 56.47<br>(68) | 56.61<br>(98) | 56.59<br>(196) | 56.81<br>(628) | 56.69<br>(342) | 56.77<br>(344) | 56.71<br>(246) | 56.61<br>(284) | 56.73<br>(198) |

one-man bridles. Liberations were made in the following areas:—

| Area                                   | Period                | Number of liberations<br>by type of tag |                          |
|----------------------------------------|-----------------------|-----------------------------------------|--------------------------|
| Upper Moray Firth<br>(‘halflin’ stock) | March                 | 1117                                    | Lea 757<br>Scottish 360  |
| North-eastern North Sea                | April-May             | 800                                     | Lea                      |
| Shetland .....                         | June-July             | 773                                     | Lea                      |
| North Minch .....                      | February<br>and April | 1083                                    | Lea                      |
| Clyde .....                            | December              | 395                                     | Lea 169<br>Scottish 226  |
| Total .....                            |                       | 4168                                    | Lea 3582<br>Scottish 586 |

Recaptures up to 8. March 1956 totalled 61, of which 58 were Lea tags and 3 Scottish tags. Details of the regions in which recaptures were made are shown in Table 31.

The results from the North Sea taggings show the same general pattern as in previous years. A very interesting record from the Minch tagging is of a herring which was tagged off the Island of Lewis on 10. February 1956 and was recaptured 75 days later at 59°25'N., 03°00'E. (N. of The Patch) having travelled at a minimum average rate

Table 30. Maturity and racial characters — South Minch

| A. Percentage maturity (all age-groups)                   |                |                |                |                |                |
|-----------------------------------------------------------|----------------|----------------|----------------|----------------|----------------|
| Maturity stage                                            | Jan.           | Feb.           | Mar.           | Oct.           | Nov.           |
| I .....                                                   | 9.20           | 8.00           | 10.80          | 11.60          | 11.29          |
| II .....                                                  | 1.20           | 2.80           | 1.60           | 4.80           | 14.11          |
| III .....                                                 | 0.80           | 2.00           | —              | 1.20           | 18.55          |
| IV .....                                                  | —              | 3.20           | —              | 0.40           | 5.65           |
| V .....                                                   | —              | 1.20           | —              | —              | 1.21           |
| VI .....                                                  | 0.80           | 0.40           | 1.60           | 1.20           | 0.81           |
| VII .....                                                 | 1.60           | 1.20           | 5.20           | 33.20          | 4.03           |
| VII—II .....                                              | 86.40          | 81.20          | 80.80          | 47.60          | 44.35          |
| Number .....                                              | 250            | 250            | 250            | 250            | 248            |
| B. Mean Vert. S. for each maturity stage (all age-groups) |                |                |                |                |                |
| (Nos. in brackets are no. of fish)                        |                |                |                |                |                |
| I .....                                                   | 56.96<br>(23)  | 57.05<br>(19)  | 57.12<br>(26)  | 56.82<br>(28)  | 56.42<br>(26)  |
| II .....                                                  | 56.67<br>(3)   | 56.71<br>(7)   | 56.50<br>(4)   | 56.90<br>(12)  | 56.82<br>(33)  |
| III .....                                                 | 56.50<br>(2)   | 56.80<br>(5)   | —              | 57.00<br>(3)   | 56.91<br>(45)  |
| IV .....                                                  | —              | 56.88<br>(8)   | —              | 57.00<br>(1)   | 57.21<br>(14)  |
| V .....                                                   | —              | 57.00<br>(3)   | —              | —              | 57.50<br>(2)   |
| VI .....                                                  | 56.00<br>(2)   | 57.00<br>(1)   | 56.50<br>(4)   | 56.33<br>(3)   | —              |
| VII .....                                                 | 57.00<br>(4)   | 56.33<br>(3)   | 56.33<br>(12)  | 56.41<br>(83)  | 56.20<br>(10)  |
| VII—II .....                                              | 56.46<br>(213) | 56.55<br>(197) | 56.52<br>(196) | 56.47<br>(117) | 56.47<br>(106) |
| Overall mean ..                                           | 56.51<br>(247) | 56.62<br>(243) | 56.57<br>(242) | 56.52<br>(247) | 56.64<br>(236) |



**Table 31. Recaptures of Scottish tagged herring, 1956**

(Numbers in brackets are days at liberty)

| Liberations       | Area of recapture         | Lea         | Scottish |
|-------------------|---------------------------|-------------|----------|
| Upper Moray Firth | Upper Moray Firth         | 19 (0-13)   | 1 (8)    |
|                   | Scottish north-east coast | 1 (100)     | 1 (113)  |
|                   | Total .....               | 20          | 2        |
|                   | Percentage of liberations | 2.6         | 0.6      |
| North-eastern Sea | Fladen .....              | 3 (41-112)  | —        |
|                   | Skagerak .....            | 2 (245-254) | —        |
|                   | Total .....               | 5           | —        |
|                   | Percentage of liberations | 0.6         | —        |
| Shetland          | Fladen .....              | 10 (2-52)   | —        |
|                   | Scottish north-east coast | 1 (45)      | —        |
|                   | Total .....               | 11          | —        |
|                   | Percentage of liberations | 1.4         | —        |
| North Minch       | North Minch .....         | 13 (0-242)  | —        |
|                   | Bressay Ground .....      | 1 (211)     | —        |
|                   | N. of The Patch .....     | 1 (75)      | —        |
|                   | Unknown .....             | 2           | —        |
|                   | Total .....               | 17          | —        |
|                   | Percentage of liberations | 1.6         | —        |
| Clyde             | Clyde .....               | 5 (10-28)   | 1 (0)    |
|                   | Percentage of liberations | 3.0         | 0.4      |

of about 4 miles a day. This return and that of another herring tagged about the same time and recaptured on the Bressay Ground in September provide further evidence of a link between the herring of the North Sea and of the Scottish west coast (Ann. Biol., XI).

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### Survey of the German Commercial Herring Fisheries and the Biological Conditions of the Stocks

(Tables 32-37)

#### A. The Fishing

The total herring landings of the German fishing fleet are recorded in Table 32. The total catch has decreased approximately by 25.82%. This is mainly due to the smaller catches of the trawlers (22.69%) and luggers (10.70%) in the North Sea and to the catches for industrial purposes of the cutters (49.36%).

##### 1. Herring trawlers

a) The spring fishery was centred on the Viking Bank and in the Utsira region from January to May. The total landings of this season amounted to 4785 tons of herring, 4286 tons being caught on the Viking Bank and 499 tons at Utsira. Only one trip came from the Shetland area. 68 trips were made as compared with 71 in 1955. To the Viking Bank 61 trips (50 in 1955) were made and 7 only

to Utsira (21 in 1955). The total yield was almost the same as in the previous season; in the Viking Bank area the yield increased from 3406 to 4286 tons as the result of increased effort, whereas at Utsira the yield decreased from 1636 to 499 tons as the result of reduced effort.

The catch per day's fishing (7.7) was nearly 2 tons greater than in the previous season (5.8 tons). In the Viking Bank area and at Utsira there was an increase from 6.7 to 8.0 tons and from 4.8 to 8.0 tons, respectively.

b) The summer/autumn fishery started on the Fladen Ground area ca. 10. June and was carried on for 102 days until about mid-September (100 days in 1955). The trawlers made 609 trips (1955 = 689) and the total yield decreased from 104,951 to 70,587 tons (32.74%) of herring. The catch per day's fishing decreased from 18.8 to 13.4 tons.

The fishing on the Gut took place between the beginning of August and the end of October and lasted for 43 days (70 in 1955). 69 trips were made (72 in 1955). The total yield dropped from 8495 to 6437 tons (24.22%), the catch per day's fishing showed also a decline, from 14.1 to 12.4 tons.

In the Dogger Bank area fishing commenced in the beginning of September and was continued until the end of October (81 days as against 63). 321 trips were made against 300 in 1955. The total yield in this area decreased slightly from 37,417 to 34,878 tons (6.79%) and the catch per day showed also a decline, from 14.6 to 12.1 tons.

The yield of the German herring trawl fishery in the summer/autumn season of 1956 in the North Sea has decreased from 156,000 to 111,902 tons (28.27%).

c) In the Channel fishery in November/December 196 trips were made as against 265 in 1955. The total yield declined from 33,750 to 18,704 tons (44.58%). The catch per day decreased from 14.0 to 11.4 tons. In November the bulk of the catch came from Sandettié (6709 tons), in December from Dieppe (11,341 tons). Three trips were made to Eddystone. In the Sandettié area the catch per day amounted to 9.8 tons (1955 = 15.0 tons), at Dieppe 15.2 tons (16.1 in 1955).

As the result of the reduced yields on the usual fishing grounds the trawlers started fishing on the Viking Bank and Utsira at the end of October. The total yield in the areas was 3483 tons in 61 trips. 3255 tons were caught off Utsira, 588 tons on the Viking Bank. The main catch was made off Utsira in November. The catch per day was 10.5 tons of herring at Utsira and 3.8 tons on the Viking Bank.



Table 32. Total herring landings (in tons) of the German fishing fleet in 1956

| Types of fishing vessels                                   | North Sea                | Channel            | Kattegat/<br>Skagerak | Total                    |
|------------------------------------------------------------|--------------------------|--------------------|-----------------------|--------------------------|
| <b>Trawler</b>                                             |                          |                    |                       |                          |
| Herring trawl fishery I—XII .....                          | 120,574<br>(155,960)     | 18,704<br>(33,750) | —                     | 139,278<br>(189,710)     |
| Trawl fishery for demersal and mixed catches; I—VI, XI—XII | 2,672                    | —                  | —                     | 2,672                    |
| <b>Drifter</b>                                             | (1,858)                  |                    |                       | (1,858)                  |
| III—XII .....                                              | 56,004<br>(62,711)       | 6,753<br>(5,817)   | —                     | 62,757<br>(68,528)       |
| <b>Deep-sea cutter</b>                                     |                          |                    |                       |                          |
| Herring trawl fishery (for consumption) I—V, VIII—XII ...  | 218.3<br>(740.6)         | —                  | 2<br>(163)            | 220.3<br>(903.6)         |
| (for factories) VI—X .....                                 | 24,281<br>(47,951)       | —                  | —                     | 24,281<br>(47,951)       |
| <b>Total</b> .....                                         | 203,749.3<br>(269,220.6) | 25,457<br>(39,567) | 2<br>(163)            | 229,206.3<br>(308,950.6) |

( ) = 1955

**2. Drifters**

From March to June 1956 a part of the German drifter fleet operated in the northern North Sea (Viking Bank/Utsira) in order to market fresh herring.

In 1956 a total of 7899 tons fresh herring were landed (1955 = 3544 tons), of which 23.62% were caught by trawl. The number of trips increased from 86 to 185. The catch per day's fishing was 4.7 tons as against 4.6 in 1955. The increased yield in 1956 is the result of increased effort.

From the North Sea was landed 47,025 tons of salt herring; the number of landings was somewhat smaller than in 1955 (548/606) and only 21.7% of these herring were caught by trawl. The catch per day fell from 4.4 to 3.6 tons (drift-net) and from 5.4 to 4.1 tons (trawl). In the northern areas (Fladen and Gut) a considerable reduction in the total yield could be noted. On the Fladen Ground the catch fell from 15,409 to 7,906 tons (48.69%) and on the Gut from 20,795 to 11,391 tons (45.22%). Finally the catch per day's fishing fell sharply from 6.2 to 2.5 tons for the drift-nets and from 7.5 to 5.0 tons for the trawls. The corresponding figures for the Gut were 4.3 to 3.9 tons (drifters) and 7.4 to 4.7 tons (trawlers).

In the Dogger area, however, the yield rose from 10,389 to 17,461 tons (40.51%) and fishing was carried out on 4373 days (2785 in 1955). The drift-nets accounted chiefly for this increase, the catch per day showing an improvement of 0.6 tons (from 3.1 to 3.7), while the trawls provided 4.2 tons only, against 6.1 in 1955. The following table shows the shift of the catch from the edge of the Dogger more westwards:—

## Drift-net catches in the Dogger area (in kantjes)

|                     | 1955   | 1956   |
|---------------------|--------|--------|
| Dogger to 1°E. .... | 61,751 | 49,146 |
| 1°E. to 2°W. ....   | 3,010  | 71,607 |

Fishing in the Southern Bight ("Binnensee") showed a slight increase, from 8080 to 8212 tons, while the number of fishing days were reduced by 584 days (2396/1812); the catch per fishing day rose from 3.5 to 4.3 tons.

In the Channel the number of fishing days were reduced by 64 days (1820/1756), the total yield, however, rose from 5817 to 6753 tons. The catch taken per day by the drift-nets was 3.7 tons (3.6) and 3.5 tons (4.8) by the trawls.

**3. Cutters**

The total yield of herring from the deep-sea and coastal cutters in the North Sea fell from 1537 to 750 tons. Only 37 trips against 50 were made by the deep-sea cutters for herring for human consumption. The total output fell from 734 to 290 tons; the catch per trip was 7.8 tons against 14.7.

The total yield of the herring fishery for oil production decreased by 49.52% and fell from 47,951 to 24,209 tons, the total number of trips being 1233 as against 2039.

**B. The Herring Stock**

Eighty-five samples comprising 14,271 herring were investigated and the main results are given in Tables 33—37.

**1. Viking Bank/Utsira and Shetland/Otter Bank area**

In this area 24 samples (2616 fish) were examined in February and March. The average sizes of the herring in the Viking Bank/Utsira area in the

Table 33. Length composition of all samples ( $^0/_{00}$ )

| Gear Area             | Trawl<br>Otter<br>Bank/<br>Shet-<br>land | Trawl<br>Utsira/<br>Viking Bank |       | Trawl<br>Fladen Ground/<br>Bressay Shoal |       |       | Trawl<br>Gut | Trawl<br>Dogger Bank |       | Trawl/Drift-net<br>Binnensee<br>(East Anglia) |       | Trawl<br>Channel |       | Young<br>herring<br>east of<br>Dogger<br>Bank |
|-----------------------|------------------------------------------|---------------------------------|-------|------------------------------------------|-------|-------|--------------|----------------------|-------|-----------------------------------------------|-------|------------------|-------|-----------------------------------------------|
| Month                 | III                                      | II                              | III   | VI                                       | VII   | VIII  | IX           | IX                   | X     | X                                             | X     | XI               | XII   | VIII                                          |
| cm. 39 .....          | 7                                        | 3                               | —     | —                                        | —     | —     | —            | —                    | —     | —                                             | —     | —                | —     | —                                             |
| 38 .....              | 34                                       | 20                              | —     | —                                        | —     | —     | —            | —                    | —     | —                                             | —     | —                | —     | —                                             |
| 37 .....              | 146                                      | 78                              | —     | —                                        | —     | —     | —            | —                    | —     | —                                             | —     | —                | —     | —                                             |
| 36 .....              | 210                                      | 90                              | —     | —                                        | —     | —     | —            | —                    | —     | —                                             | —     | —                | —     | —                                             |
| 35 .....              | 137                                      | 83                              | —     | —                                        | —     | —     | —            | —                    | —     | —                                             | —     | —                | —     | —                                             |
| 34 .....              | 105                                      | 58                              | 4     | —                                        | —     | —     | —            | —                    | —     | —                                             | —     | —                | —     | —                                             |
| 33 .....              | 89                                       | 111                             | 22    | —                                        | —     | I     | —            | —                    | —     | —                                             | —     | —                | —     | —                                             |
| 32 .....              | 97                                       | 145                             | 60    | —                                        | —     | 6     | 11           | —                    | —     | I                                             | —     | —                | —     | —                                             |
| 31 .....              | 69                                       | 102                             | 125   | 3                                        | 3     | 49    | 33           | 11                   | —     | 5                                             | —     | —                | —     | —                                             |
| 30 .....              | 63                                       | 101                             | 193   | 12                                       | 13    | 174   | 114          | 31                   | 4     | 21                                            | 3     | 10               | 30    | —                                             |
| 29 .....              | 27                                       | 85                              | 153   | 24                                       | 42    | 265   | 184          | 33                   | 31    | 53                                            | 50    | 70               | 80    | —                                             |
| 28 .....              | 16                                       | 70                              | 224   | 46                                       | 106   | 219   | 158          | 62                   | 73    | 75                                            | 110   | 130              | 130   | I                                             |
| 27 .....              | —                                        | 32                              | 138   | 115                                      | 204   | 172   | 152          | 83                   | 119   | 110                                           | 159   | 100              | 210   | I                                             |
| 26 .....              | —                                        | 8                               | 56    | 255                                      | 287   | 88    | 92           | 78                   | 103   | 114                                           | 120   | 60               | 140   | 2                                             |
| 25 .....              | —                                        | 8                               | 17    | 276                                      | 199   | 14    | 158          | 77                   | 102   | 124                                           | 113   | 110              | 80    | I                                             |
| 24 .....              | —                                        | I                               | 6     | 192                                      | 94    | 7     | 22           | 135                  | 146   | 179                                           | 213   | 110              | 70    | 2                                             |
| 23 .....              | —                                        | I                               | —     | 54                                       | 30    | 4     | 33           | 198                  | 125   | 199                                           | 209   | 150              | 160   | 4                                             |
| 22 .....              | —                                        | 3                               | 2     | 12                                       | 16    | I     | 11           | 116                  | 61    | 73                                            | 23    | 210              | 100   | 5                                             |
| 21 .....              | —                                        | —                               | —     | 6                                        | 7     | —     | 16           | 57                   | 36    | 10                                            | —     | 40               | —     | 22                                            |
| 20 .....              | —                                        | —                               | —     | —                                        | —     | —     | 16           | 44                   | 39    | 2                                             | —     | 10               | —     | 107                                           |
| 19 .....              | —                                        | —                               | —     | —                                        | —     | —     | —            | 40                   | 23    | 2                                             | —     | —                | —     | 183                                           |
| 18 .....              | —                                        | I                               | —     | 3                                        | —     | —     | —            | 26                   | 23    | 2                                             | —     | —                | —     | 216                                           |
| 17 .....              | —                                        | —                               | —     | 2                                        | —     | —     | —            | 8                    | 3     | 8                                             | —     | —                | —     | 165                                           |
| 16 .....              | —                                        | —                               | —     | —                                        | —     | —     | —            | I                    | —     | 4                                             | —     | —                | —     | 31                                            |
| 15 .....              | —                                        | —                               | —     | —                                        | —     | —     | —            | —                    | —     | 6                                             | —     | —                | —     | 26                                            |
| 14 .....              | —                                        | —                               | —     | —                                        | —     | —     | —            | —                    | —     | 6                                             | —     | —                | —     | 94                                            |
| 13 .....              | —                                        | —                               | —     | —                                        | —     | —     | —            | —                    | —     | I                                             | —     | —                | —     | 122                                           |
| 12 .....              | —                                        | —                               | —     | —                                        | —     | —     | —            | —                    | —     | 4                                             | —     | —                | —     | 18                                            |
| 11 .....              | —                                        | —                               | —     | —                                        | —     | —     | —            | —                    | —     | I                                             | —     | —                | —     | —                                             |
| Total .....           | 1000                                     | 1000                            | 1000  | 1000                                     | 1000  | 1000  | 1000         | 1000                 | 1000  | 1000                                          | 1000  | 1000             | 1000  | 1000                                          |
| Number .....          | 678                                      | 1174                            | 464   | 667                                      | 1228  | 841   | 184          | 2949                 | 2282  | 824                                           | 301   | 100              | 100   | 1979                                          |
| Av. length, cm.       | 34.69                                    | 32.72                           | 29.45 | 25.91                                    | 26.54 | 28.84 | 27.68        | 24.45                | 25.41 | 25.23                                         | 25.78 | 24.70            | 25.70 | 17.64                                         |
| Males, $^0/_{00}$ ... | 553                                      | 499                             | 451   | 480                                      | 527   | 530   | 454          | 400                  | 538   | 440                                           | 550   | 560              | 630   | 83                                            |

different months were 32.75 cm. and 29.45 cm. respectively (Table 33). It appears from Table 35 that maturity stage V predominated greatly in February, whereas stages VII and V were most frequent in March. The age composition of the catches indicates that the 3—6 year-old fish were predominant ( $769^0/_{00}$ ). According to their relative strength the sequence of the most important year-classes was the following:— 1950,  $288^0/_{00}$ ; 1953,  $186^0/_{00}$ ; 1952,  $160^0/_{00}$ ; 1951,  $135^0/_{00}$ . The total number of vertebrae (V. S.) is given in Table 36 showing the average number to be 56.81. The average number in relation to maturity stage gives a higher value (56.96) for stages III—VI (Table 37) indicating that the catches have been a mixture of different stocks, and gill-raker counts confirm this opinion. The bulk of the catches consisted of large Atlantic and North Sea late winter spawners and some autumn spawners.

In the Shetland/Otter Bank area the average size of the herring was 34.69 cm. in March and maturity stages V—VII were predominant ( $982^0/_{00}$ ). The catches were composed principally of fish 4—6 years and more than 10 years old ( $816^0/_{00}$ ), and the sequence of the most important year-classes was the following:— 1945 and older,  $343^0/_{00}$ ; 1951,  $217^0/_{00}$ ; 1952,  $140^0/_{00}$ ; 1950,  $116^0/_{00}$ . The average number of vertebrae was 56.99 and the catch was composed of late winter spawners.

In November/December a new fishery started in the Viking Bank/Utsira area. The average length of the herring caught there was 29.13 cm. and the majority of the fish were in maturity stage IV and V ( $567^0/_{00}$ ). The principal components in the catches were the 1951 and 1952 year-classes ( $560^0/_{00}$ ) but the 1949 year-class was of some importance also constituting  $142^0/_{00}$ . The average vertebral count was 56.81 and the catches proved to be a mixture of

Table 34. Age composition of all samples (‰)

| Gear     |            | Trawl |      | Trawl        |        | Trawl   |      | Trawl |      | Trawl  |        | Trawl/Drift-net |   | Trawl   |   | Trawl                             |
|----------|------------|-------|------|--------------|--------|---------|------|-------|------|--------|--------|-----------------|---|---------|---|-----------------------------------|
| Locality |            | Otter |      | Viking Bank/ |        | Fladen  |      | Gut   |      | Dogger |        | Binnensee       |   | Channel |   | Young herring east of Dogger Bank |
|          |            | Bank/ |      | Utsira       |        | Ground/ |      |       |      | Bank   |        | (East Anglia)   |   |         |   |                                   |
|          |            | Shet- |      |              |        | Bressay |      |       |      |        |        |                 |   |         |   |                                   |
|          |            | lands |      |              |        | Shoal   |      |       |      |        |        |                 |   |         |   |                                   |
| Month    |            |       |      |              |        |         |      |       |      |        |        |                 |   |         |   |                                   |
|          | Year-class | Age   | III  | II/III       | XI/XII | VI—IX   | IX   | IX/X  | X    | X      | XI/XII | VIII            |   |         |   |                                   |
|          | 1955       | 1     | —    | —            | —      | —       | —    | —     | —    | —      | —      | —               | — | —       | — | 243                               |
|          | 1954       | 2     | 5    | 7            | 15     | —       | 53   | 230   | 3    | —      | —      | —               | — | —       | — | 730                               |
|          | 1953       | 3     | 5    | 186          | 27     | 187     | 224  | 394   | 475  | 465    | 415    | 23              |   |         |   |                                   |
|          | 1952       | 4     | 140  | 160          | 278    | 440     | 257  | 184   | 186  | 279    | 166    | 4               |   |         |   |                                   |
|          | 1951       | 5     | 217  | 135          | 282    | 171     | 112  | 67    | 171  | 118    | 98     | —               |   |         |   |                                   |
|          | 1950       | 6     | 116  | 288          | 98     | 70      | 39   | 35    | 84   | 53     | 145    | —               |   |         |   |                                   |
|          | 1949       | 7     | 63   | 34           | 142    | 48      | 59   | 31    | 36   | 27     | 52     | —               |   |         |   |                                   |
|          | 1948       | 8     | 39   | 34           | —      | 34      | 46   | 25    | 21   | 21     | 52     | —               |   |         |   |                                   |
|          | 1947       | 9     | 53   | 31           | 11     | 24      | 92   | 13    | 15   | 21     | 47     | —               |   |         |   |                                   |
|          | 1946       | 10    | 19   | 13           | 15     | 12      | 46   | 9     | 6    | 16     | 10     | —               |   |         |   |                                   |
|          | < 1946     | > 10  | 343  | 112          | 72     | 14      | 72   | 12    | 3    | —      | 15     | —               |   |         |   |                                   |
| Total    |            |       | 1000 | 1000         | 1000   | 1000    | 1000 | 1000  | 1000 | 1000   | 1000   | 1000            |   |         |   |                                   |
| Number   |            |       | 207  | 556          | 266    | 632     | 152  | 1481  | 333  | 187    | 193    | 474             |   |         |   |                                   |

Table 35. Sexual maturity in all samples (‰)

| Gear   |  | Trawl |      | Trawl        |      | Trawl         |      | Trawl |      | Trawl       |      | Trawl/Drift-net |      | Trawl   |        | Young herring east of Dogger Bank |
|--------|--|-------|------|--------------|------|---------------|------|-------|------|-------------|------|-----------------|------|---------|--------|-----------------------------------|
| Area   |  | Otter |      | Viking Bank/ |      | Fladen Ground |      | Gut   |      | Dogger Bank |      | Binnensee       |      | Channel |        |                                   |
|        |  | Bank/ |      | Utsira       |      |               |      |       |      |             |      | (East Anglia)   |      |         |        |                                   |
|        |  | Shet- |      |              |      |               |      |       |      |             |      |                 |      |         |        |                                   |
|        |  | lands |      |              |      |               |      |       |      |             |      |                 |      |         |        |                                   |
| Month  |  |       |      |              |      |               |      |       |      |             |      |                 |      |         |        |                                   |
| Stages |  | III   | II   | III          | VI   | VII           | VIII | IX    | IX   | IV          | IX   | X               | X    | X       | XI/XII | VIII                              |
| I      |  | —     | 7    | 2            | 240  | 157           | 25   | 20    | 71   | 1000        | 310  | 233             | 102  | —       | —      | 962                               |
| II     |  | 9     | 51   | 36           | 380  | 193           | 220  | 30    | 55   | —           | 67   | 76              | 55   | 25      | —      | 18                                |
| III    |  | —     | 3    | 2            | 290  | 333           | 100  | 20    | 22   | —           | 94   | 27              | 10   | 10      | —      | 8                                 |
| IV     |  | 9     | 31   | 18           | 90   | 243           | 165  | 50    | 126  | —           | 139  | 90              | 167  | 310     | —      | 12                                |
| V      |  | 645   | 667  | 387          | —    | 73            | 410  | 330   | 541  | —           | 268  | 325             | 550  | 625     | 5      | —                                 |
| VI     |  | 174   | 117  | 32           | —    | —             | 20   | —     | 27   | —           | 61   | 29              | 68   | 5       | 790    | —                                 |
| VII    |  | 163   | 124  | 523          | —    | —             | 60   | 540   | 158  | —           | 61   | 220             | 48   | 25      | 205    | —                                 |
| Total  |  | 1000  | 1000 | 1000         | 1000 | 1000          | 1000 | 1000  | 1000 | 1000        | 1000 | 1000            | 1000 | 1000    | 1000   | 1000                              |

Table 36. Total number of vertebrae (V.S.) ‰

| Area  |  | Otter Bank/ |         | Viking Bank/      |      | Fladen Ground |      | Gut     |      | Dogger |  | Binnensee     |  | Channel |  | Young herring east of Dogger Bank |
|-------|--|-------------|---------|-------------------|------|---------------|------|---------|------|--------|--|---------------|--|---------|--|-----------------------------------|
|       |  | Shetlands   |         | Utsira            |      |               |      |         |      | Bank   |  | (East Anglia) |  |         |  |                                   |
| Month |  |             |         |                   |      |               |      |         |      |        |  |               |  |         |  |                                   |
| V.S.  |  | III         | II, III | III, IV, VI, VIII | IX   | IX, X         | X    | XI, XII |      |        |  |               |  |         |  |                                   |
| 59    |  | 3           | 7       | —                 | —    | 2             | —    | 5       | 4    |        |  |               |  |         |  |                                   |
| 58    |  | 178         | 145     | 43                | 39   | 55            | 82   | 76      | 49   |        |  |               |  |         |  |                                   |
| 57    |  | 624         | 599     | 416               | 382  | 489           | 518  | 485     | 488  |        |  |               |  |         |  |                                   |
| 56    |  | 181         | 231     | 464               | 522  | 410           | 363  | 404     | 426  |        |  |               |  |         |  |                                   |
| 55    |  | 14          | 14      | 77                | 51   | 38            | 30   | 30      | 25   |        |  |               |  |         |  |                                   |
| 54    |  | —           | 3       | —                 | —    | 6             | 7    | —       | 5    |        |  |               |  |         |  |                                   |
| 53    |  | —           | 1       | —                 | 6    | —             | —    | —       | 1    |        |  |               |  |         |  |                                   |
| Total |  | 1000        | 1000    | 1000              | 1000 | 1000          | 1000 | 1000    | 1000 |        |  |               |  |         |  |                                   |

Table 37. Total number of vertebrae (V.S.) in relation to stages of maturity

| Area                  | Otter Bank<br>Shetlands |       | Viking Bank/<br>Utsira |       | Fladen<br>Ground  |       | Gut    |       | Dogger Bank |       | Binnensee<br>(East Anglia) |       | Channel |       |
|-----------------------|-------------------------|-------|------------------------|-------|-------------------|-------|--------|-------|-------------|-------|----------------------------|-------|---------|-------|
| Month                 | III                     |       | II, III                |       | III, IV, VI, VIII |       | IX     |       | IX, X       |       | X                          |       | XI, XII |       |
| Stages of<br>maturity | Number                  | Aver. | Number                 | Aver. | Number            | Aver. | Number | Aver. | Number      | Aver. | Number                     | Aver. | Number  | Aver. |
| Immature . . .        | —                       |       | —                      |       | 26                | 56.69 | 13     | 56.69 | 278         | 56.63 | 5                          | 56.80 | —       |       |
| II . . . . .          | —                       |       | 6                      | 56.50 | 88                | 56.53 | 15     | 56.47 | 45          | 56.27 | 16                         | 56.63 | —       |       |
| III—IV . . . .        | —                       |       | —                      |       | 62                | 56.52 | —      |       | 255         | 56.61 | —                          |       | —       |       |
| III—VI . . . .        | 218                     | 56.99 | 257                    | 56.96 | —                 |       | 120    | 56.42 | —           |       | 298                        | 56.59 | —       |       |
| V—VI . . . . .        | —                       |       | —                      |       | 12                | 56.50 | —      |       | 387         | 56.57 | —                          |       | 149     | 56.61 |
| VII . . . . .         | —                       |       | 67                     | 56.60 | —                 |       | —      |       | —           |       | —                          |       | 34      | 56.71 |
| VII—VII/II            | 35                      | 57.00 | —                      |       | 2                 | 56.50 | 30     | 56.40 | 128         | 56.34 | 22                         | 56.45 | —       |       |
| VII/II . . . . .      | —                       |       | 53                     | 56.40 | —                 |       | —      |       | —           |       | —                          |       | 7       | 57.00 |
| Total . . . . .       | 253                     | 56.99 | 383                    | 56.81 | 190               | 56.55 | 178    | 56.44 | 1093        | 56.55 | 341                        | 56.59 | 190     | 56.64 |

different populations, chiefly late winter spawners (71.53%) presumably from the Skagerak. The average vertebral count for stages III—V was 56.95 (68.47%), whereas stages II and VII—II (V. S. = 56.50) were autumn spawners (28.47%).

## 2. Fladen Ground

From this area 13 samples containing 2636 fish were investigated. The average length increased from 25.91 cm. in June, to 28.84 cm. in August, (see Table 33). The maturity was advancing from June to September, in June stages I—III were predominant, while in July, stages III and IV were more frequent, and in August the bulk of the fish had reached stages V—VI. The first spent herring were observed in the last 10 days of August, while in September, the majority of the catches consisted of spent herring (540/00), (Table 35).

The age composition shows the predominance (440/00) of the rich 1952 year-class (4-year-olds). The year-classes next in importance are those of 1953 (187/00) and 1951 (171/00), (Table 34).

The average number of vertebrae found was 56.55 (Table 37). The vertebral average of immature herring was markedly higher (56.69) than for those of stages II to VII—II (56.50—56.53). The bulk of the catches was formed by North Sea autumn spawners (Bank herring), and only a small admixture of late winter spawners was observed, as confirmed by the gill-raker counts.

## 3. Gut

Three samples from September containing 184 herrings were examined. The average length was 27.68 cm. (Table 33). Maturity stage V was predominant (541/00), but spent herring were also present (158/00).

The age composition showed resemblance to that from the Fladen Ground in so far as the 1952 year-class was predominant (257/00). The year-classes next in importance were 1953 (224/00) and 1951 (112/00), (Table 34).

The average number of vertebrae was 56.44 (Table 37). The vertebral average of immature herring was somewhat higher (56.69) than the averages of stages II—VII (56.47—56.40). This was caused by the presence of some late winter spawners. The majority of the herring were autumn spawners.

## 4. Dogger Bank area

From this area 27 samples containing 5231 fish were investigated. The average lengths in September and October were 24.45 cm. and 25.41 cm. respectively (Table 33).

In both months large quantities of herring in maturity stage I were present (310 and 233/00, respectively). Stages IV and V predominated in September, while in October the bulk of the herring were in stages V and VII (Table 35).

The 3-year-old fish predominated with 394/00, and next in abundance were the broods of 1954 (230/00) and 1952 (184/00), (Table 34).

The average number of vertebrae was 56.55. Autumn spawners of the bank herring type were those in maturity stages V—VII, while the immature and stages III—IV were a mixture of the Bank and Downs groups.

## 5. East Anglia ("Binnensee")

Five samples from the trawl and two samples from the drift-net catches comprising 1125 herrings were investigated.

The average lengths for the trawl were 25.23 cm. and 25.78 cm. for the drift-net in October (Table 33).

The majority of the herring from both gears had reached maturity stages IV—V in October (Tab. 35). The 3-year-olds were predominant as well in the trawl as in the drift-net catches. The sequence of the most important year-classes in the trawl catches were 1953, 475/00; 1952, 186/00; and 1951, 171/00. The same age composition was found in the drift-net catches (Table 34).

The average number of vertebrae was 56.59 and the relation of vertebral average to maturity is



given in Table 37. According to meristic characters, the herring population in this area was composed of autumn spawners, for the main part belonging to the Downs group (stages II—VI). Only a small admixture of Bank herring was present (stages VII and VII—II).

#### 6. The Channel

Only two samples containing 200 fish were investigated. The average length was 24.7 cm. in November, and 25.7 in December, (Table 33). Maturity stage VI was the predominant one in both months (790<sup>0</sup>/<sub>00</sub>), (Table 35).

The most important year-classes were 1953 (415<sup>0</sup>/<sub>00</sub>), 1952 (166<sup>0</sup>/<sub>00</sub>), and 1950 (145<sup>0</sup>/<sub>00</sub>), (Table 34). The average number of vertebrae was 56.64 (Table 37). The catches were probably a mixture of the Downs and Channel groups.

#### 7. Young herring east of the Dogger Bank

In August, 6 samples comprising 1979 fish were investigated. The average length was 17.64 cm. More than 900<sup>0</sup>/<sub>00</sub> of these herring were immature. Age-group I was the most important component in the age composition (730<sup>0</sup>/<sub>00</sub>). The proportion of the 0-group was remarkably high this year (243<sup>0</sup>/<sub>00</sub>). The average number of vertebrae was 56.55, and the stock belonged presumably to the central and southern North Sea groups.

#### Prospects

In 1955 a decline in the yields occurred on all the German trawl-fishing grounds. On the northern grounds (Fladen-Gut) this decrease amounted to 28.27%. In the central area (Dogger) the fishery was also a failure. There the yield dropped by ca. 6.79%. Only the drifters showed an increase of 40.51% in the Dogger area. The investigations showed that the drifter fleet moved their operations farther westwards because herring were not available in sufficient quantities on the edge of the Dogger. A decrease of 44.58% was found in the Channel area for the trawlers, whereas the drifters had a slight increase. In the young herring fishery east of the Dogger the yields also declined, by about 49.52%.

The Bank herring forms the majority of the German herring fishery in the North Sea. Since 1922 a rather comprehensive material concerning the age composition of the catches has been collected. From this material it has been generally found that the catches on the Dogger Bank mainly consisted of 3-year-olds and older, and those on the Fladen

Ground of 4-year-olds and older. Not until 1954 (and 1955 in an even higher degree) was it experienced that the 3-year-old herring predominated in the northern North Sea also and were present there in a higher proportion than on the Dogger. It is noticeable that this phenomenon coincides with the onset of the decline in the landings from the Dogger. In August 1955 the hydrographic conditions in the North Sea were unusual; the two centres of winter bottom water on the Fladen Ground and the Gut were unusually cold this year. The distribution of salinity was also extraordinary, water of high salinity and low temperature covered even the northern border of the Dogger.

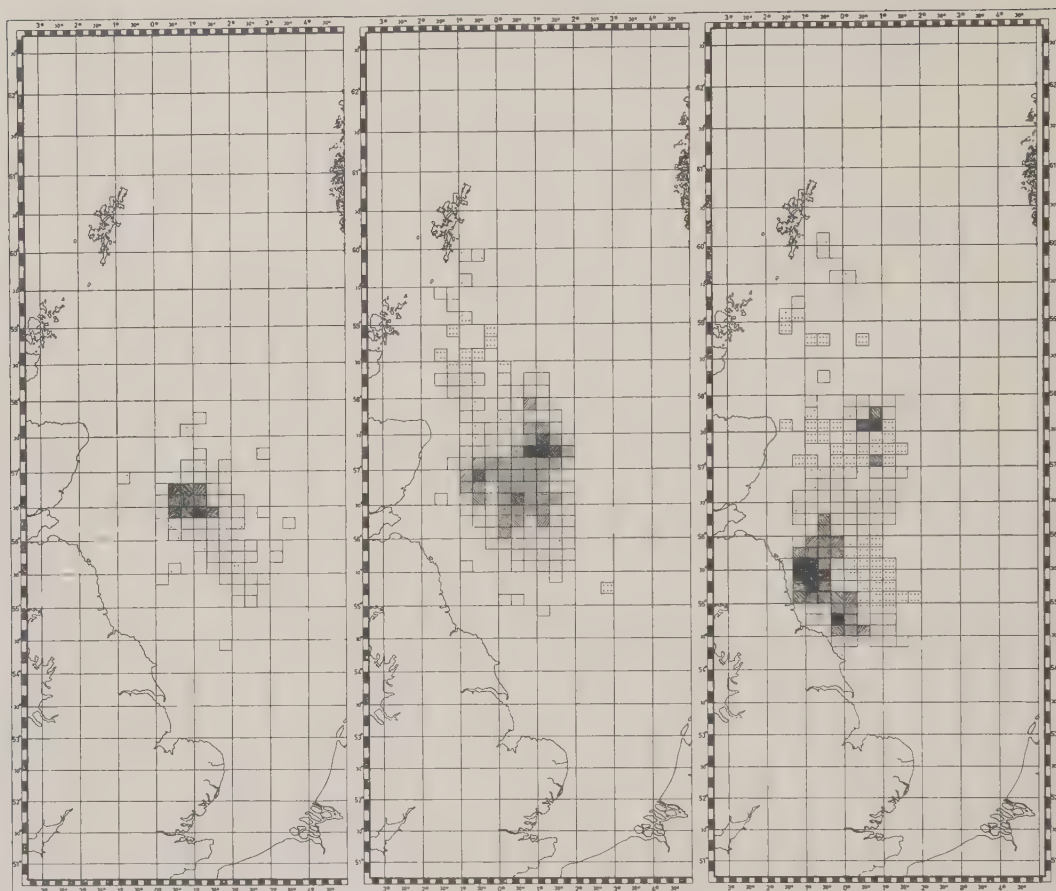
In 1955 and 1956, from the end of September to mid-October, spawning on the Dogger was observed only in the south-western area. In other years spawning took place also in other localities along the north-western and western edges of the Dogger. From about mid-September until October the spawning shifted from the north-western to the western Dogger and later on to south-west and south. In 1956 a hydrographic situation corresponding to that of 1955 was observed in mid-September on the north and north-western Dogger. The bottom temperatures were still lower than in 1955 (8—10°C.), presumably as a result of the very cold spring. From these facts it might be assumed that a special hydrographic situation is guiding the recruit spawners and occasionally is preventing the onset of spawning in some years.

The Bank stock investigations in 1955 showed the presence of a good year-class, 3 years old, and born in 1952. In 1956 this age-group provided a still greater part of the catches. The following 1953 year-class was not so strong. A similar age composition as in 1956 was observed in 1922 and 1925. Judging from the relative frequency of year-classes we may assume that 4-year-old herring of the 1953 year-class and also the 5-year-old fish (1952) will be plentiful on the northern and central North Sea fishing grounds in summer and autumn 1957.

With regard to the fishery on the different North Sea grounds in 1957 it is difficult to say anything definite at the moment. It will depend chiefly upon the recruit spawners and the hydrographic conditions. The quantity of recruit spawners cannot yet be forecasted as the hydrographic situation seems to be better in the 1957 season than in the preceding years because of the higher winter temperatures in 1956/57.

K. SCHUBERT

Number of Shots



Charts 13—15.

May

June

July

### Young Herring from the Bløden Ground Area

Sampling from commercial catches and continuous market measurements were carried out on the same level as in the two previous years.

The total weight of commercial catches landed in Esbjerg showed an increase of 16% from 1955. This was due to a very good spring season which yielded 21.2 mill. kg. (8.3 mill. kg. in 1955). The autumn season yielded 52.8 mill. kg. against 55.3 mill. kg. in 1955 (all species included).

Compared with former years the disappearance of cold bottom water from the Bløden area took place about one month earlier than usual (vide p.13). This caused a dispersion of the herring shoals and led to an increase in number of fishing days per trip, together with a northerly displacement of the main fishing area during the later half of the autumn season.

On the main the development of the fishery and composition of the catches were in agreement with earlier observations.

K. POPP MADSEN

### The Herring Fisheries in the Netherlands in 1956

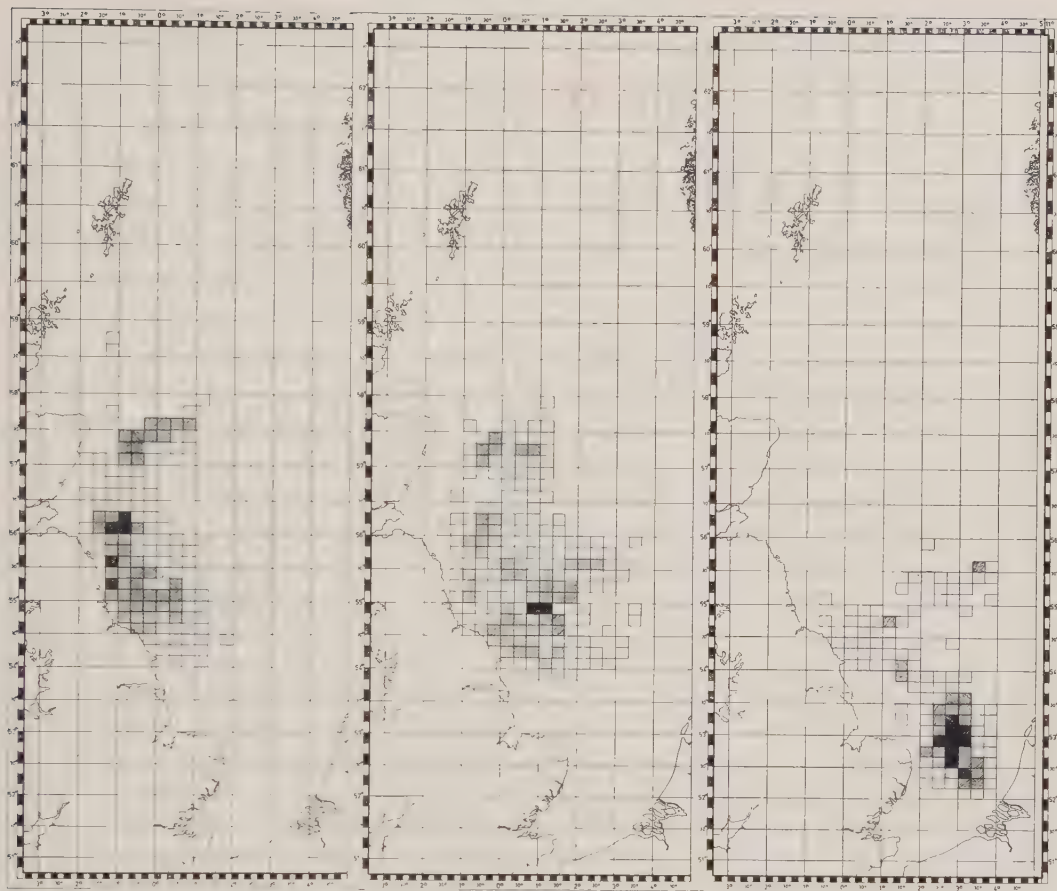
(Figure 16; Table 38; Charts 13—41)

#### Drift-net fisheries

The drift-net fishery started on 23. May 1956 and ended in December.

A great number of lugger skippers again provided information on the area of fishing and on the size of their catches. Charts 13—28 show effort and catches, computed for each month for an area of 10 × 10 miles. The actual figures, on which these charts are based, can be found in *Bulletin Statistique* for 1956.

Number of Shots

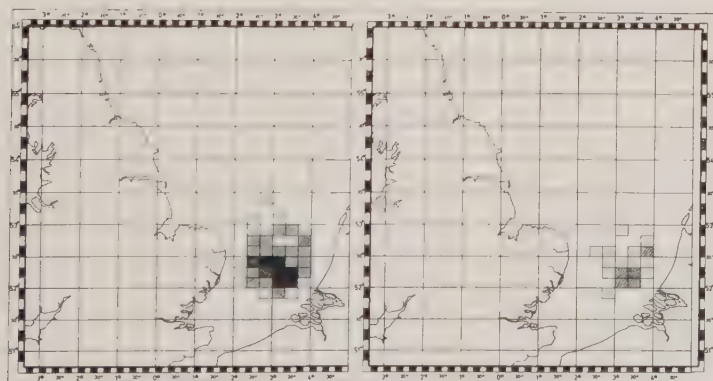


Charts 16-18.

August

September

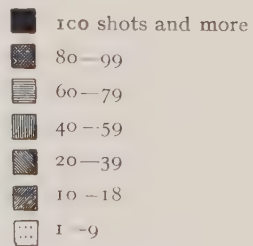
October



Charts 19-20.

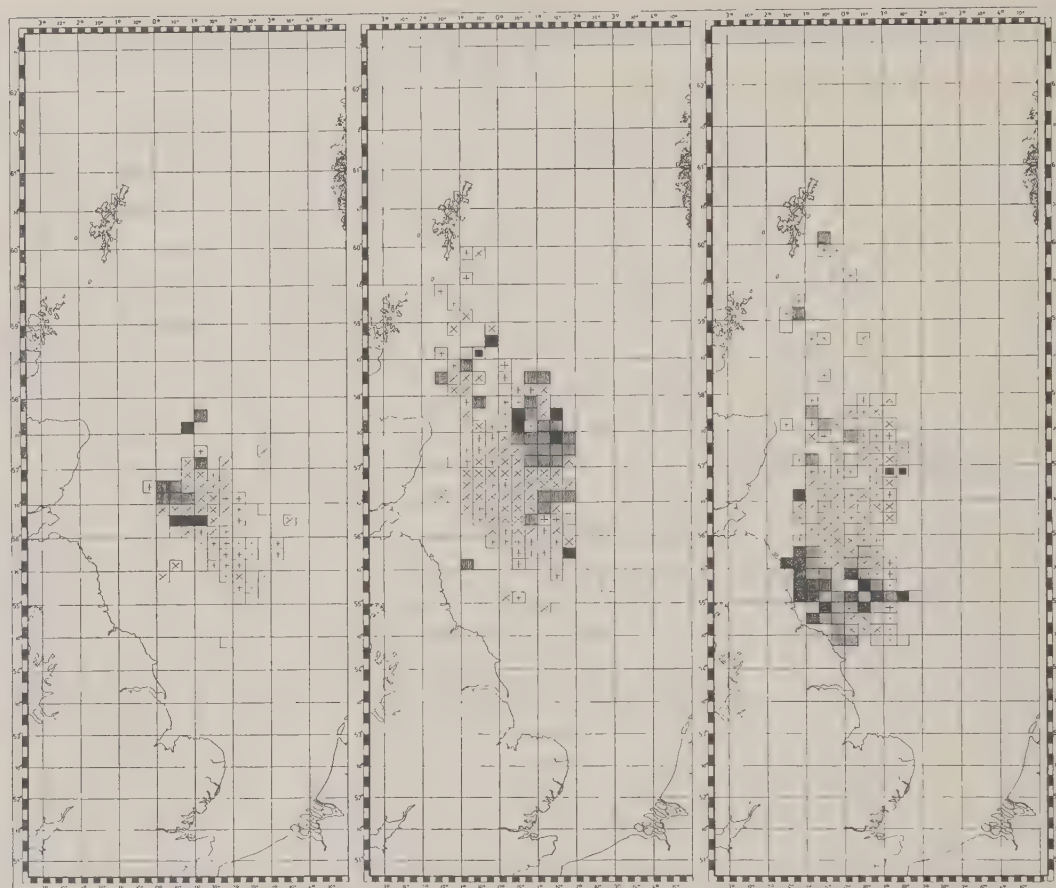
November

December





## Mean Catch per Shot (Kantjes)



Charts 21—23.

May

June

July

The number of nets in operation was altered in the course of the season; from 23.—29. May 60 nets were allowed; from 29. May to 15. July, 90 nets; and after 15. July, 100—120 nets.

From the charts it may be noticed that in summer (May—August) fishing was centred rather more to the south than in 1955, especially in July and August. Catches in the southern part of the summer fishing area were much better than in 1955. On the whole, the summer fishing was rather successful.

In the period September—December the distribution of the fleet was in accordance with the normal pattern. The catches in this period remained approximately on the same low level as in the preceding year.

Fishing in the Dogger area (September—October) ended early and the catches were definitely low in

comparison with those of some years ago. In this region a steady decline in the catches can be observed for the last 10 years.

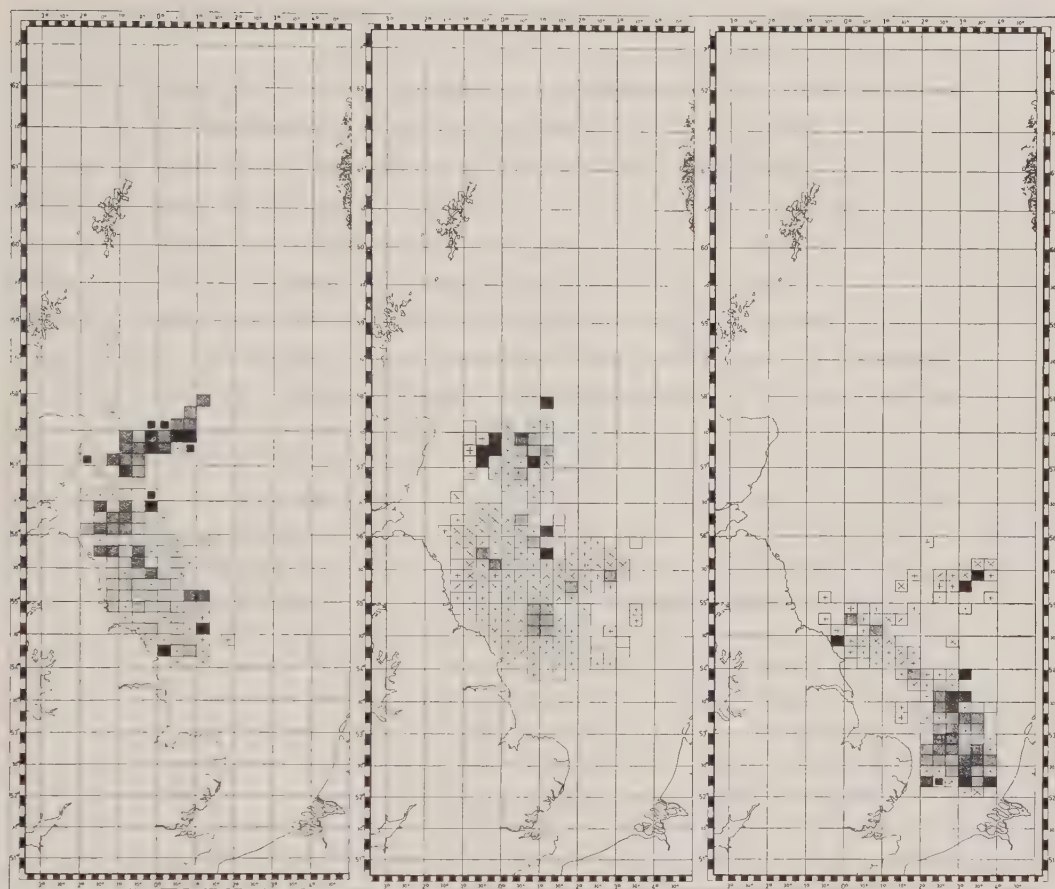
The East Anglian season (October—December) gave slightly better results than in 1955, when the average catch was the lowest since the end of the war (catch per shot in 1956, 46 kantjes; in 1955, 42 kantjes). The year 1956 is the second in succession in which the East Anglian fishery gave unsatisfactory results.

Fishing in the English Channel (not shown in the charts) was hindered by bad weather and was not very successful.

As a whole the herring season of 1956 was rather good. The mean catch per shot for the whole season was 39.7 kantjes compared with 38.1 kantjes in 1955.



Mean Catch per Shot (Kantjes)

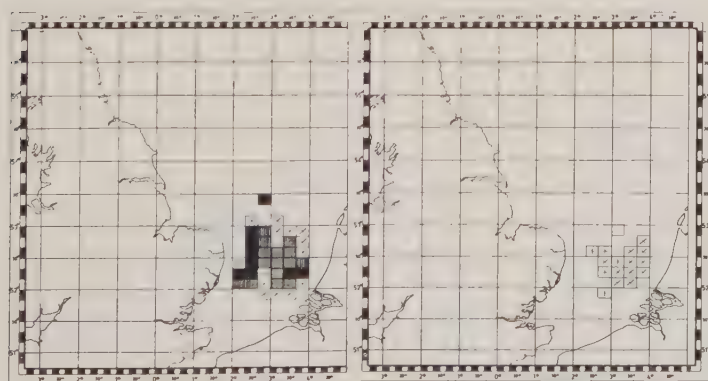


Charts 24—26.

August

September

October

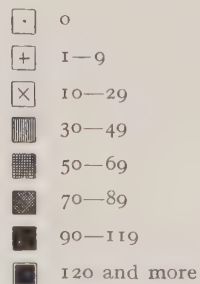


Charts 27—28.

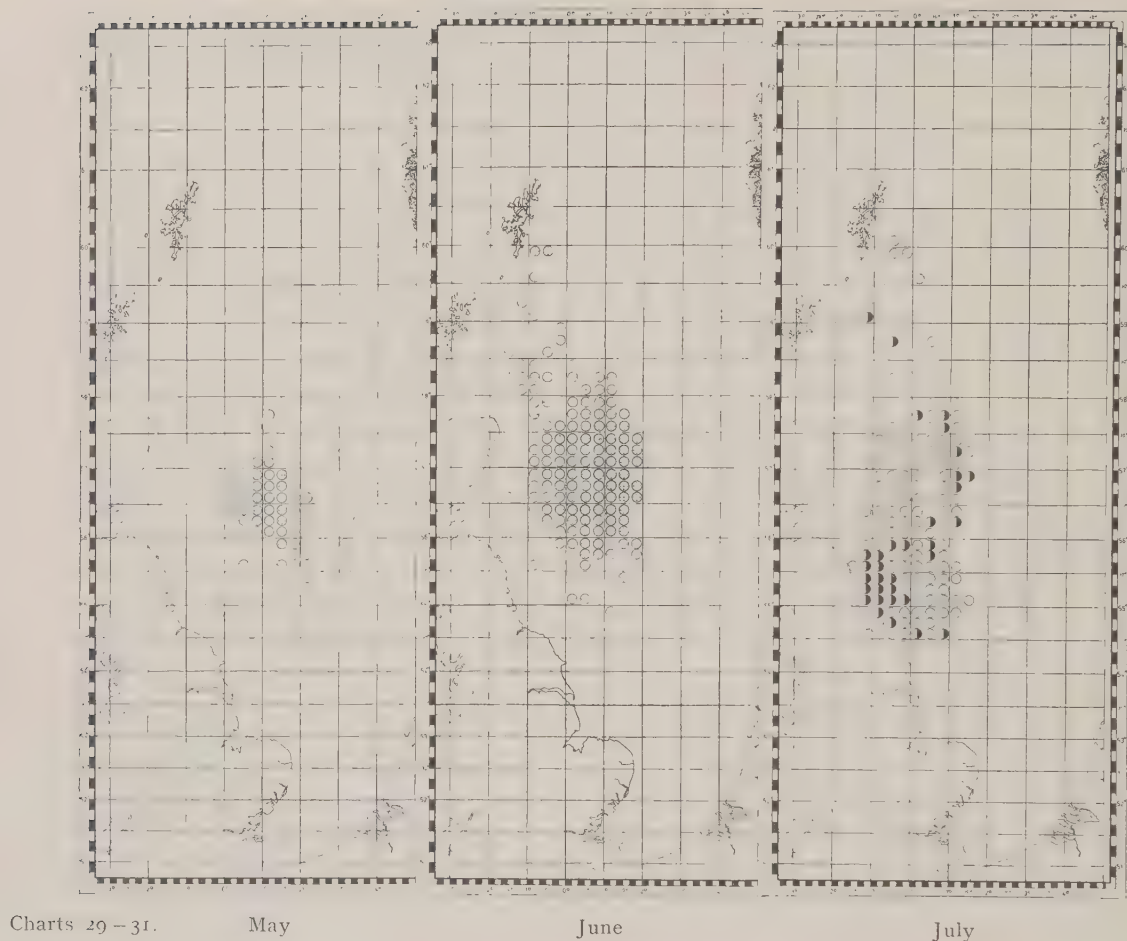
November

December

Mean Number of  
Kantjes per Shot



# Sorting



The sorting of the herring, shown in Charts 29—36, was in accordance with the customary pattern.

Table 38A shows the total quantity of drift-net herring landed throughout the year. The total weight of herring landed by drift-net fisheries in Dutch ports was 72,875 tons, whereas 77,476 tons were landed in 1955.

## Trawl fisheries

Statistics of the monthly catch of herring per 100 hours fishing by Dutch steam and motor trawlers are given in Charts 37—41.

In general, the distribution of the fleet followed the customary pattern. An exception, however, is the catches of herring in the north-eastern North Sea in October and November. This new fishery came probably into being because of poor catches

on the grounds usually fished in these months.

In all areas catches were lower than in previous years. This reduction is more serious since, in recent years more powerful ships participate in the fishery. A steady decline in the catches has been observed in most areas.

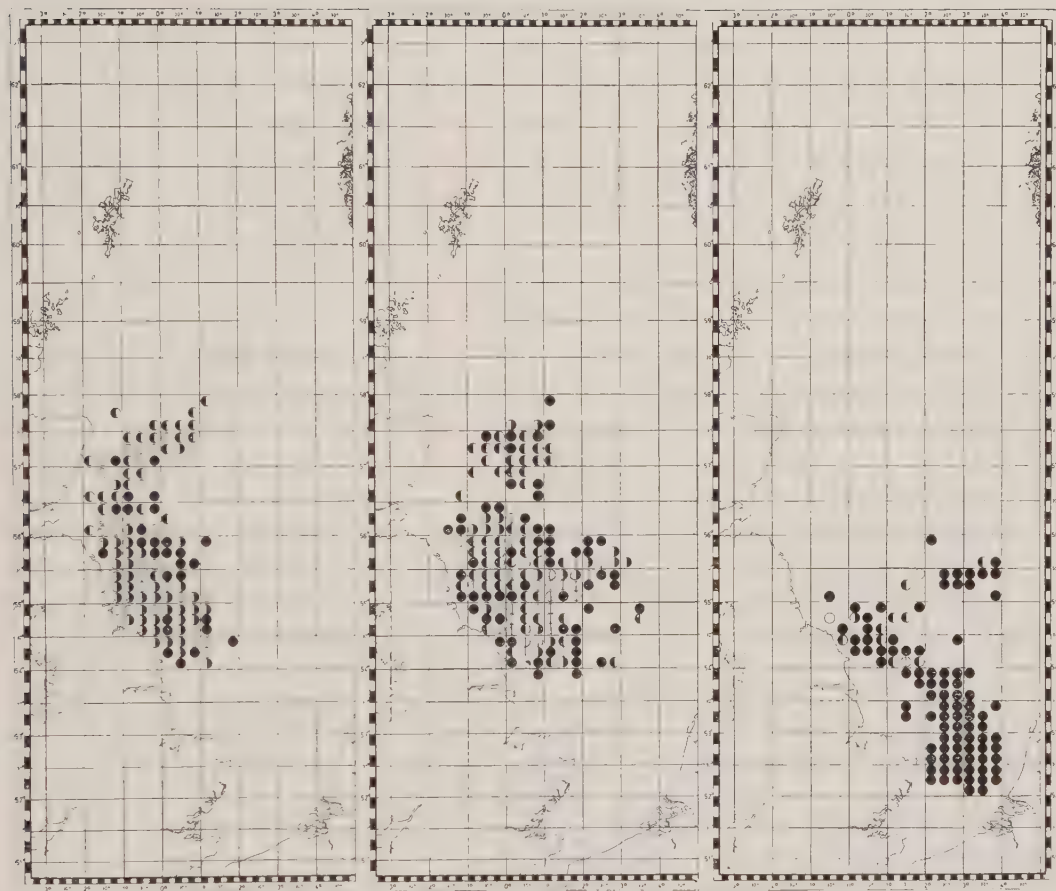
Compared with the year 1955 it appears that the most serious reduction has occurred on the Fladen Ground and in the Downs area.

Table 38 B gives the total quantity of herring landed by trawlers and by the whole fleet, fishing with herring trawl. The total quantity of trawled herring dropped from 48,471 tons in 1955 to 45,041 tons in 1956.

## Age composition

Samples of herring were collected from the spawning areas on the south-western Dogger

Sorting

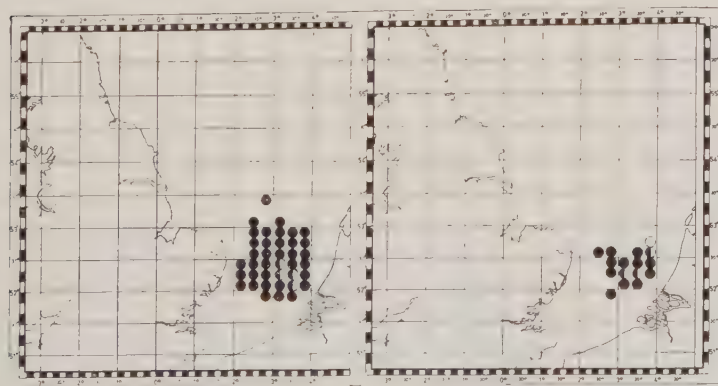


Charts 32—34.

August

September

October



Charts 35—36. November

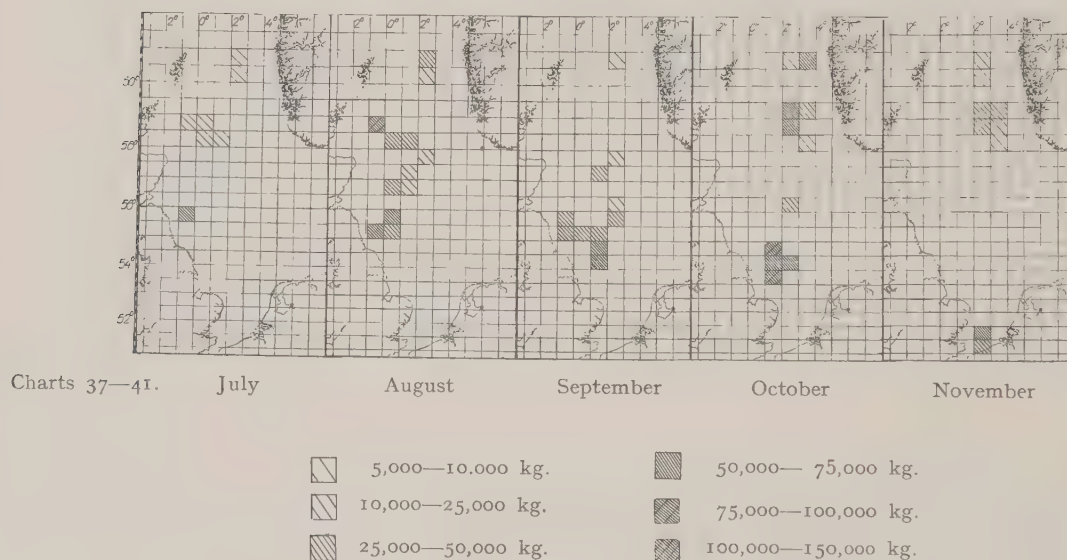
December

- Matjes
- Matjes and Full
- ⊖ Matjes, Full and Spent
- Full and Spent
- Full
- Spent

Table 38. Quantities of herring landed in Dutch ports in 1956

| Month            | A. Landed by luggers fishing with drift-nets |             |        |          |                        | B. Trawled herring (in tons) |                      |
|------------------|----------------------------------------------|-------------|--------|----------|------------------------|------------------------------|----------------------|
|                  | Salted herring (in kantjes)                  |             |        |          | Fresh herring (in kg.) | Trawlers                     | All kinds of vessels |
|                  | Matjes                                       | Gutted full | Spent  | Ungutted |                        |                              |                      |
| January .....    | —                                            | —           | —      | 2,133    | 49,450                 | 68                           | 564                  |
| February .....   | —                                            | —           | —      | 3,507    | 100,850                | 59                           | 310                  |
| March .....      | —                                            | —           | —      | 1,007    | 19,450                 | 60                           | 488                  |
| April .....      | —                                            | 10          | 26     | 3,113    | 201,727                | 605                          | 1,122                |
| May .....        | 7,950                                        | —           | 150    | 979      | 297,900                | 286                          | 553                  |
| June .....       | 60,247                                       | —           | —      | 14,912   | 1,032,101              | 294                          | 863                  |
| July .....       | 80,878                                       | 334         | —      | 26,939   | 1,621,135              | 1,004                        | 3,014                |
| August .....     | 35,929                                       | 31,036      | 4,863  | 20,642   | 261,810                | 2,447                        | 7,246                |
| September .....  | 5,722                                        | 42,967      | 12,883 | 30,828   | 202,370                | 2,698                        | 7,512                |
| October .....    | 1,637                                        | 27,697      | 5,519  | 114,521  | 3,264,713              | 3,165                        | 6,237                |
| November .....   | —                                            | 1,796       | 117    | 104,309  | 3,514,518              | 1,411                        | 2,562                |
| December .....   | —                                            | 181         | 4      | 41,097   | 755,213                | 583                          | 1,890                |
| Total 1956 ..... | 192,363                                      | 104,021     | 23,562 | 363,987  | 11,321,237             | 12,680                       | 32,361               |

Dutch Trawl Catches per 100 Hours Fishing



Bank (September—October), Sandettié area (November), and English Channel (December). The samples were taken from commercial vessels, fishing with the herring trawl. Herring in maturity stage VI (running roe and milt) were selected from the samples. The age composition, given in Figure 16, refer to these herring only.

The age composition of the spawners of the Dogger area has been based on analyses of 40 samples, containing 1300 herrings in stage VI. From the Sandettié area 5 samples with 400 herrings in stage VI have been collected. The age composition of the Channel spawning grounds

has been based on 22 samples with 1100 herrings in stage VI.

A sampling programme was carried out for the drift-net fishery in the East Anglian region. The sampling method used was generally the same as described by HODGSON (Rapp. et Proc. Verb., Vol. CX, 1939, 31—38). A total of 25,000 herrings have been measured and 56 samples of 30 herrings have been used for age determinations. The sampling period extended from 13. October until 16. December. The resulting age composition is shown in Figure 16.

J. ZIJLSTRA



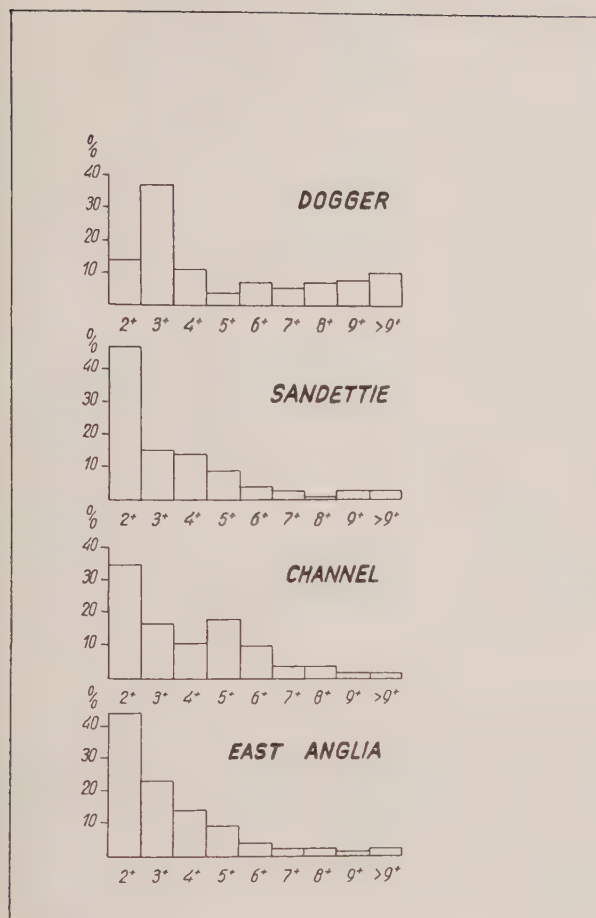


Figure 16. Age composition of spawning herring in the Dogger, Sandettié, and Channel areas (trawl), and age composition of herring from the East Anglian fishery (drift-net).

## The Belgian Herring Fisheries in 1956—1957 (30. July 1956 — 19. January 1957)

(Figure 17; Tables 39—49)

### The North Sea — English Channel

#### 1. Regions — fishing gear

The statistics of the herring fishery distinguishes between three, more or less well-defined regions, viz., 1) the northern area, where the fishery is mainly centred in the Fladen Ground area; 2) the central area, where fishing is carried out on the Gut, the Dogger Bank, and in the waters west and south of this bank, and 3) the southern area, where fishing is carried out in a rather narrow zone situated between the "Hinders" Bank and the entrance to the eastern English Channel, including the Sandettié area.

In the northern and central areas of the North Sea fishing was carried out exclusively with the otter-trawl, whereas in the southern area nearly all catches were obtained by the pelagic trawl, towed by two trawlers fishing together.

This fishery yielded in all 3,277 tons of fish, of which 3,038 tons were herring; 616 tons of the herring were caught with otter-trawl (20.3%) and the pelagic trawl took 2,422 tons (79.7%).

#### 2. Otter-trawl: fishing effort — landings

Tables 39—41 give records of fishing effort and yields obtained by vessels operating with the otter-trawl. Only 9 trawlers participated in the fishery and made 20 trips during the season (Table 39). The catches were mainly composed of herring (Table 40), the yield of which totalled 616 tons (Table 41) or 76.5% as against 1,228 tons in the previous season. The average catch per 100 F. H. x H. P. (47 kg.) was 35 kg. or 42.7% lower than in the previous season (82 kg.).

#### 3. Pelagic trawl: fishing effort — landings

This fishery was localized in the extreme south of the North Sea and the eastern English Channel.

Owing to the lack of remunerative catches, the activity of the trawlers was very restricted. The first catches from this region were landed at the beginning of October and the last on 19. January 1957.

In Table 42, a survey is given of the fishery effort and yields, in comparison with the previous season. In the 1956 season 56 trawlers were engaged in the fishing (87 in 1955—56) and 381 (1,179) voyages were made.

The total catch amounted to 2,471 tons consisting of 2,422 tons herring, or 98.02%, 2 tons or 0.08% mackerel, 3 tons or 0.13% other pelagic species, and 44 tons or 1.77% demersal species.

Table 42 gives further details about the landings made with the pelagic trawl. The average catch per 100 F. H. x H. P. reached only 137 kg. as against 302 kg. in 1955—56, or 54.6% less. This average yield varied considerably from month to month. It reached its maximum in January 1957 with 194 kg. and its minimum in December with 126 kg.

### The Herring Stock

#### 1. Southern North Sea

As the landings of herring from the northern and central areas of the North Sea were rather scarce and irregular it was not possible to obtain a sufficient number of samples for studying the biological composition of the stocks present there. Thus these studies have been limited to the stocks inhabiting the southern North Sea.

Table 39. Number of trips with otter-trawl and fishing effort

| Months           | Number of trips |        |        |       | Fishing effort (1,000 F.H. x H.P.) |        |        |       |
|------------------|-----------------|--------|--------|-------|------------------------------------|--------|--------|-------|
|                  | North.          | Centr. | South. | Total | North.                             | Centr. | South. | Total |
| July .....       | 1               | —      | —      | 1     | 171                                | —      | —      | 171   |
| August .....     | 6               | 1      | —      | 7     | 793                                | 27     | —      | 820   |
| September .....  | —               | —      | —      | —     | —                                  | —      | —      | —     |
| October .....    | 1               | —      | —      | 1     | 54                                 | —      | —      | 54    |
| November .....   | 4               | —      | 7      | 11    | 232                                | —      | 35     | 267   |
| Total 1956 ..... | 12              | 1      | 7      | 20    | 1,250                              | 27     | 35     | 1,312 |
| Total 1955 ..... | 8               | 25     | 19     | 52    | 512                                | 889    | 91     | 1,492 |

Table 40. The total yields by otter-trawl vessels

| Species                      | Tons | ‰     |
|------------------------------|------|-------|
| Pelagic Herring .....        | 616  | 765   |
| „ Mackerel .....             | 87   | 107   |
| „ Horse Mackerel .....       | 3    | 4     |
| Demersal Haddock .....       | 15   | 18    |
| „ Cod .....                  | 7    | 9     |
| „ Saithe .....               | 21   | 26    |
| „ Whiting .....              | 45   | 55    |
| „ Others .....               | 12   | 16    |
| Total pelagic species .....  | 706  | 876   |
| Total demersal species ..... | 100  | 124   |
| Grand Total .....            | 806  | 1,000 |

Table 42.

| Fishing effort and yield of the fishery with pelagic trawl |                    |                                         |                                   |
|------------------------------------------------------------|--------------------|-----------------------------------------|-----------------------------------|
| Number of trips                                            | Total catch (tons) | Average catch per 100 F.H. x H.P. (kg.) | Fishing effort (1000 F.H. x H.P.) |
| Months                                                     | trips              | (tons)                                  | H.P. (kg.)                        |
| October .....                                              | 32                 | 193                                     | 137                               |
| November .....                                             | 241                | 1,585                                   | 137                               |
| December .....                                             | 87                 | 503                                     | 126                               |
| January .....                                              | 21                 | 141                                     | 194                               |
| Total 1956-57 .                                            | 381                | 2,422                                   | Mean 137                          |
| Total 1955-56 .                                            | 1,179              | 11,528                                  | Mean 302                          |

Table 41. The yields of herring (otter-trawl)

| Months           | Total catch (tons) |        |        |       | Average catch per 100 F.H. x H.P. (kg.) |        |        |       |
|------------------|--------------------|--------|--------|-------|-----------------------------------------|--------|--------|-------|
|                  | North.             | Centr. | South. | Total | North.                                  | Centr. | South. | Total |
| July .....       | 36                 | —      | —      | 36    | 21                                      | —      | —      | 21    |
| August .....     | 303                | 34     | —      | 337   | 38                                      | 125    | —      | 41    |
| September .....  | —                  | —      | —      | —     | —                                       | —      | —      | —     |
| October .....    | 20                 | —      | —      | 20    | 37                                      | —      | —      | 37    |
| November .....   | 211                | —      | 12     | 223   | 91                                      | —      | 35     | 84    |
| Total 1956 ..... | 570                | 34     | 12     | 616   | 46                                      | 125    | 35     | 47    |
| Total 1955 ..... | 243                | 814    | 172    | 1,229 | 48                                      | 91     | 188    | 82    |

The material investigated consisted of 16 samples comprising 1,050 fish; they were collected in October (140), November (560), December 1956 (245), and in January 1957 (105).

Table 43 shows the size distribution of the herring from month to month during the season. The average weight and the percentage of males are also recorded. The average size of the fish (251 mm.) was lower than in 1955-56 (269 mm.), the average weight was 106 g. as against 134 g. in 1955-56.

As to the maturity, it is evident from Table 44 that stage V was greatly predominant during October and stages VIII-II in the other months. As in earlier investigations the quantity of intestinal fat was estimated. The results are shown in Table 45.

The age composition is shown in Table 46. It appears that the 3-year-old fish were predominant during all months. The sequence of the most important year-classes, as to their relative strength proved to be as follows:—1953 (523‰), 1952 (167‰), and 1951 (116‰).

The age composition of the catches from year to year is given in Table 47. This table deals with the 4-year period from 1953-54 to 1956-57. The youngest year-classes seem to predominate during this period.

The average length of the herring and the growth-rate during the first year ( $L_1$ ) is given in Table 48.

The number of vertebrae varies between 54 and 60 (Table 49). The spines with 57 vertebrae

Table 43. Size, weight, and sex (‰)

| cm.                     | Southern North Sea |      |      |      | E. Chan.         |                  |               |
|-------------------------|--------------------|------|------|------|------------------|------------------|---------------|
|                         | Oct.               | Nov. | Dec. | Jan. | Total<br>1956-57 | Total<br>1955-56 | Dec.-<br>Jan. |
| 31 ....                 | —                  | —    | —    | —    | —                | 2                | —             |
| 30 ....                 | 14                 | 23   | 16   | 38   | 23               | 22               | 41            |
| 29 ....                 | 43                 | 80   | 37   | 124  | 71               | 129              | 71            |
| 28 ....                 | 50                 | 77   | 37   | 114  | 70               | 185              | 82            |
| 27 ....                 | 136                | 112  | 53   | 172  | 118              | 164              | 118           |
| 26 ....                 | 93                 | 86   | 73   | 133  | 96               | 172              | 71            |
| 25 ....                 | 121                | 91   | 90   | 57   | 90               | 146              | 88            |
| 24 ....                 | 293                | 170  | 200  | 162  | 206              | 104              | 153           |
| 23 ....                 | 207                | 236  | 294  | 124  | 215              | 62               | 253           |
| 22 ....                 | 22                 | 102  | 180  | 76   | 95               | 7                | 94            |
| 21 ....                 | 14                 | 14   | 20   | —    | 12               | 3                | 23            |
| 20 ....                 | 7                  | 7    | —    | —    | 4                | 2                | 6             |
| Total ..                | 1000               | 1000 | 1000 | 1000 | 1000             | 1000             | 1000          |
| Average length, mm. .   | 253                | 254  | 246  | 264  | 251              | 269              | 254           |
| Mode, cm. .             | 24                 | 23   | 23   | 27   | 23               | 28               | 23            |
| Average weight, g. .... | 141                | 127  | 99   | 121  | 106              | 134              | 110           |
| Males ‰                 | 521                | 477  | 539  | 457  | 495              | 479              | 471           |

dominate and the vertebral average was found to be 56.595.

Finally Table 50 gives the number of keeled scales ( $K_2$ ) for each month. The average number for the whole season was 14,820.

Stomach analyses were made on all herring investigated. Only 1.7 contained food, mostly remains of copepods.

## 2. The English Channel

The three samples investigated were taken from catches made off Dieppe during the period December 1956 to January 1957. A total of 170 herrings was studied.

The size distribution, the average size, and the weight of the herring can be seen in Table 43. The average length of the fish was 254 mm., the average weight 110 g.

The maturity and the quantity of intestinal fat are given in Tables 44 and 45. The greatest part of the stock was just spent or recovering spents, and the small quantity of fat is in good agreement with that fact.

The age composition is shown in Table 46. Here also the 3-year-old fish is predominant (520‰). The 3-5-year-old herring (year-classes 1953-1951) contributed altogether 792 ‰ of the total catch.

The number of vertebrae varies between 54 and 58 (Table 49), with mode 57 and average 56.659.

Table 44. Stages of maturity (‰)

| Stages    | Southern North Sea |      |      |      | E. Chan.         |                  |               |
|-----------|--------------------|------|------|------|------------------|------------------|---------------|
|           | Oct.               | Nov. | Dec. | Jan. | Total<br>1956-57 | Total<br>1955-56 | Dec.-<br>Jan. |
| I .....   | —                  | 29   | 4    | —    | 8                | 6                | 18            |
| II .....  | 36                 | 34   | 16   | 10   | 24               | 1                | 6             |
| III ..... | —                  | —    | —    | —    | —                | —                | —             |
| IV .....  | 57                 | 2    | 4    | —    | 16               | 1                | —             |
| V .....   | 879                | 266  | 8    | —    | 288              | 153              | —             |
| VI .....  | 7                  | 210  | 13   | —    | 58               | 71               | 29            |
| VII ..... | —                  | 29   | 16   | —    | 11               | 40               | 35            |
| VIII-II   | 21                 | 430  | 939  | 990  | 595              | 728              | 912           |
| Total ..  | 1000               | 1000 | 1000 | 1000 | 1000             | 1000             | 1000          |

Table 45. Quantity of intestinal fat (‰)

| Quant.   | Southern North Sea |      |      |      | E. Chan.         |                  |      |
|----------|--------------------|------|------|------|------------------|------------------|------|
|          | Oct.               | Nov. | Dec. | Jan. | Total<br>1956-57 | Total<br>1955-56 | Jan. |
| 0 .....  | 164                | 184  | 139  | 114  | 150              | 167              | 265  |
| I .....  | 743                | 738  | 829  | 876  | 797              | 818              | 712  |
| + .....  | 79                 | 46   | 24   | 10   | 40               | 13               | 12   |
| M .....  | 14                 | 32   | 8    | —    | 13               | 2                | 12   |
| Total .. | 1000               | 1000 | 1000 | 1000 | 1000             | 1000             | 1000 |
| Index .  | 1.94               | 1.93 | 1.90 | 1.90 | 1.92             | 1.85             | 1.76 |

Table 46. Age (‰)

| Year-class    | Southern North Sea |      |      |      | E. Chan.         |               |      |
|---------------|--------------------|------|------|------|------------------|---------------|------|
|               | Oct.               | Nov. | Dec. | Jan. | Total<br>1956-57 | Dec.-<br>Jan. | Jan. |
| 2 ... 1954    | 15                 | 17   | 9    | —    | 10               | —             | 6    |
| 3 ... 1953    | 564                | 466  | 679  | 384  | 523              | —             | 520  |
| 4 ... 1952    | 143                | 175  | 131  | 221  | 167              | —             | 136  |
| 5 ... 1951    | 120                | 119  | 70   | 154  | 116              | —             | 136  |
| 6 ... 1950    | 98                 | 70   | 65   | 39   | 68               | —             | 65   |
| 7 ... 1949    | 30                 | 53   | 5    | 29   | 29               | —             | 78   |
| 8 ... 1948    | 23                 | 24   | 9    | 19   | 14               | —             | 32   |
| 9 ... 1947    | —                  | 34   | 14   | 67   | 29               | —             | 7    |
| 10 ... 1946   | 7                  | 27   | 9    | 39   | 25               | —             | 7    |
| >10 ... <1946 | —                  | 15   | 9    | 48   | 18               | —             | 13   |
| Total ...     | 1000               | 1000 | 1000 | 1000 | 1000             | —             | 1000 |

Table 47. Age composition of the catches during 1953/54-1956/57 (‰)

| Age       | Southern North Sea |         |         |         |
|-----------|--------------------|---------|---------|---------|
|           | Season             |         |         |         |
|           | 1953-54            | 1954-55 | 1955-56 | 1956-57 |
| 2 .....   | 4                  | 6       | 2       | 13      |
| 3 .....   | 268                | 298     | 203     | 524     |
| 4 .....   | 225                | 222     | 258     | 164     |
| 5 .....   | 128                | 116     | 176     | 111     |
| 6 .....   | 114                | 87      | 109     | 69      |
| 7 .....   | 122                | 82      | 73      | 35      |
| 8 .....   | 82                 | 90      | 66      | 20      |
| 9 .....   | 23                 | 51      | 63      | 28      |
| 10 .....  | 18                 | 24      | 36      | 21      |
| >10 ..... | 16                 | 24      | 14      | 15      |

Table 48. Average lengths by age and the value of  $L_1$  (mm.)  
Southern North Sea

| Brood | Oct. | Nov. | Dec. | Jan. | Mean    | Mean    |
|-------|------|------|------|------|---------|---------|
|       |      |      |      |      | 1956—57 | 1955—56 |
| 1954  | 210  | 225  | 231  | —    | 223     | 205     |
| 1953  | 241  | 238  | 235  | 239  | 238     | 245     |
| 1952  | 260  | 260  | 238  | 265  | 260     | 261     |
| 1951  | 271  | 273  | 268  | 277  | 272     | 277     |
| 1950  | 282  | 284  | 283  | 278  | 283     | 283     |
| 1949  | 283  | 290  | 286  | 296  | 289     | 288     |
| 1948  | 294  | 294  | 292  | 305  | 295     | 290     |
| 1947  | —    | 296  | 298  | 291  | 295     | 290     |
| 1946  | 294  | 296  | 294  | 296  | 296     | 294     |

Table 48a. Value of  $L_1$  (mm.)  
Southern North Sea

|      | Oct. | Nov. | Dec. | Jan. | Mean    | Mean    |
|------|------|------|------|------|---------|---------|
|      |      |      |      |      | 1956—57 | 1955—56 |
| 1954 | 130  | 161  | 148  | —    | 153     | 135     |
| 1953 | 129  | 126  | 122  | 123  | 125     | 126     |
| 1952 | 126  | 125  | 124  | 131  | 126     | 122     |
| 1951 | 120  | 128  | 119  | 132  | 126     | 110     |
| 1950 | 128  | 127  | 130  | 118  | 127     | 108     |
| 1949 | 121  | 117  | 118  | 133  | 119     | 113     |
| 1948 | 110  | 116  | 111  | 134  | 116     | 111     |
| 1947 | —    | 108  | 103  | 110  | 108     | 114     |
| 1946 | 113  | 116  | 89   | 117  | 113     | —       |

Table 49. Vertebrae (V.S.  $\%_{00}$ )

| V.S.             | Southern North Sea |        |        |        | Channel          |                               |
|------------------|--------------------|--------|--------|--------|------------------|-------------------------------|
|                  | Oct.               | Nov.   | Dec.   | Jan.   | Total<br>1956—57 | Total<br>1955—56<br>Dec.—Jan. |
| 60               | —                  | —      | 4      | —      | 1                | —                             |
| 59               | —                  | —      | 9      | 10     | 5                | 1                             |
| 58               | 52                 | 44     | 82     | 30     | 52               | 67                            |
| 57               | 545                | 490    | 517    | 574    | 532              | 510                           |
| 56               | 373                | 429    | 362    | 366    | 382              | 393                           |
| 55               | 22                 | 35     | 22     | 20     | 25               | 28                            |
| 54               | 8                  | 2      | 4      | —      | 3                | 1                             |
| Total            | 1000               | 1000   | 1000   | 1000   | 1000             | 1000                          |
| Average          | 56.612             | 56.540 | 56.694 | 56.644 | 56.595           | 56.619                        |
| Standard error   | 0.6584             | 0.6481 | 0.7396 | 0.6243 | 0.6531           | 0.6642                        |
| Fluctuation mean | 0.1917             | 0.6941 | 0.1638 | 0.2095 | 0.0694           | 0.0686                        |

Table 50. Keeled scales ( $K_2$ ) in  $\%_{00}$

| $K_2$            | Southern North Sea |        |        |        | Channel          |                               |
|------------------|--------------------|--------|--------|--------|------------------|-------------------------------|
|                  | Oct.               | Nov.   | Dec.   | Jan.   | Total<br>1956—57 | Total<br>1955—56<br>Dec.—Jan. |
| 19               | —                  | —      | —      | —      | —                | 1                             |
| 18               | —                  | 2      | 4      | 10     | 4                | —                             |
| 17               | 29                 | 22     | 13     | 29     | 23               | 16                            |
| 16               | 169                | 152    | 195    | 114    | 157              | 155                           |
| 15               | 478                | 472    | 448    | 514    | 478              | 483                           |
| 14               | 280                | 307    | 278    | 314    | 295              | 302                           |
| 13               | 44                 | 43     | 62     | 19     | 42               | 41                            |
| 12               | —                  | 2      | —      | —      | 1                | 1                             |
| Total            | 1000               | 1000   | 1000   | 1000   | 1000             | 1000                          |
| Average          | 14.860             | 14.801 | 14.830 | 14.848 | 14.820           | 14.804                        |
| Standard error   | 0.8497             | 0.8462 | 0.8837 | 0.8292 | 0.8520           | 0.8205                        |
| Fluctuation mean | 0.2458             | 0.1213 | 0.1920 | 0.2728 | 0.0893           | 0.0836                        |

Table 50 gives the number of keeled scales ( $K_2$ ). The average number for this area was found to be 14.875.

All stomachs were empty when examined.

#### General observations

Comparison of numerical and biological values of herring from the southern North Sea with those from the English Channel, shows a similarity in composition of the populations present there during December 1956 and January 1957.

The difference between the average lengths observed in the two areas is 3 mm. only (251 mm. in the North Sea and 254 mm. in the Channel). The difference between the average weights is also very small, 4 g. (106 g. against 110 g.).

The frequency of recently spawned herring maturity stages VII and VIII-II) differs hardly (965 $\%_{00}$  and 947 $\%_{00}$ ). In both areas, the 2 to 6-year-old herring formed the majority (884 $\%_{00}$  and 863 $\%_{00}$ ). In consequence the older year-classes were abnormally poorly represented.



The vertebral average of the herring in the two areas was also of the same value, 56.68 and 56.66

#### Conclusions

The results of the investigations tend to show:—

- (1) that after spawning, the herring of the North Sea penetrated very deeply into the English Channel, where they probably mixed with the Channel herring populations;
- (2) that the majority of herring 6 and more years old were absent in the extreme south of the North Sea, through causes which are yet to be elucidated.

It is presumed that these two facts may be held largely responsible for the poor results of the past herring season in this area.

If these phenomena were to happen again next year, the success of the southern North Sea herring fishery in 1957—58 may once again be highly endangered.

CH. GILLIS

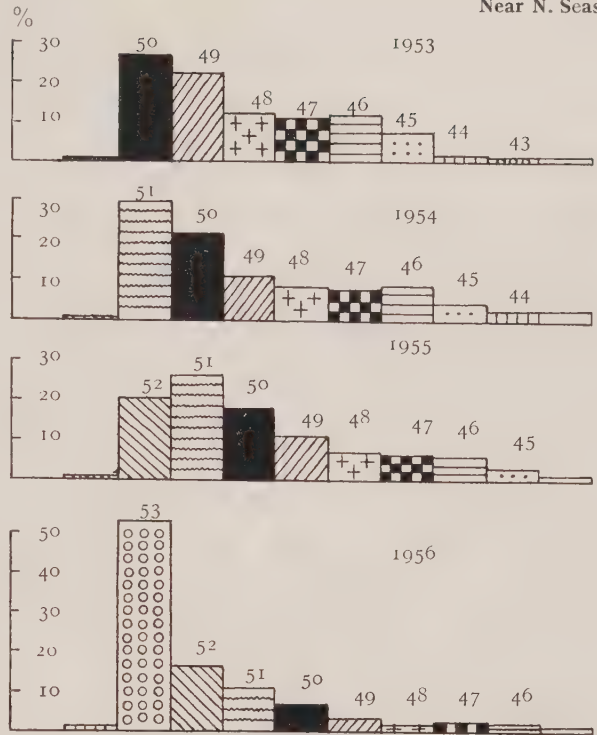


Figure 17. Biological scale of the full-herring concentrations exploited by the Belgian trawlers in 1953-1956.

## C. Baltic-Belt Seas

### YOUNG STAGES

#### Larvae in the Kattegat and the Belt Sea

The quantity of herring larvae was investigated in April by fishing with a ring-net at some few stations in the Belts and the southern Kattegat. No larvae of winter or spring spawning herring

were caught. At some stations near the spawning places of the autumn spawning herring, north and east of Læsø in the northern Kattegat, great quantities of larvae were obtained in November.

AA. J. C. JENSEN

## COMMERCIAL FISH

## Investigations on Small, Immature, and Adult Herring

(Tables 50-53)

## 1. Skagerak and northern Kattegat

Table 50 shows that the major part of the 0-ringed herring in the samples investigated in the first months of the year were mainly autumn and winter spawners from the northern Kattegat or easternmost Skagerak. In the sample from 17. January the low  $K_2$  indicates that the herring was not North Sea autumn spawners, although V.S. and V.P. would fit very well with this group, but it may

be assumed that they were mixtures between the said winter spawners and coastal spring spawners from the Kattegat.

The 0-ringed herring in the sample from 19. March must have been Kobbergrund herring mixed with autumn spawners from the western North Sea.

The 0-ringed herring in 9 samples taken between Skagen and Hirtshals in September—November and in one sample from north-east of Læsø, taken in November, were all North Sea autumn spawners.

The 1-ringed herring caught off Hirtshals in January—February were exclusively—or chiefly—

Table 50. Racial characters of young herring caught by trawl in the Baltic-Belt Seas 1956

| Date            | Locality          | Depth, m. | Number of rings | Length, cm. | V.S.  | Number | V.P.  | $K_2$ | Number |
|-----------------|-------------------|-----------|-----------------|-------------|-------|--------|-------|-------|--------|
| 17. I.          | Off Hirtshals     | 49—62     | 0               | 10—17       | 56.58 | 327    | 23.98 | 14.41 | 290    |
| 19. III.        | Off Frederikshavn | 40        | 0               | 9—15        | 56.44 | 227    | 24.13 | 14.38 | 221    |
| 24. IX.—20. XI. | Skagen—Hirtshals  | 2—40      | 0               | 8—17        | 56.54 | 1048   | 24.16 | 14.84 | 669    |
| 22. XI.         | N.E. of Læsø      | 53        | 0               | 12—17       | —     | —      | —     | 15.07 | 247    |
| 17. I.—16. II.  | Off Hirtshals     | 30—132    | 1               | 17—24       | 56.68 | 357    | 24.00 | 14.79 | 363    |
| 24. IX.—6. XI.  | Skagen—Hirtshals  | 2—40      | 1               | 16—17       | 56.47 | 122    | 24.12 | 14.80 | 135    |
| 24. IX.—6. XI.  | Skagen—Hirtshals  | 2—40      | 1               | 18—22       | 56.42 | 104    | 24.22 | 14.33 | 100    |
| 24. I.—15. V.   | N. Belt Sea       | 18—25     | 0               | 7—17        | 55.90 | 1123   | 24.38 | 14.27 | 787    |
| 1. X.—26. XI.   | N. Belt Sea       | 13—18     | 0               | 8—11        | 56.46 | 72     | 24.39 | 14.48 | 52     |
| 1. X.—30. X.    | N. Belt Sea       | 13—18     | 0               | 12—14       | 56.05 | 199    | 24.55 | 14.24 | 203    |
| 11.—26. XI.     | N. Belt Sea       | 13—18     | 0               | 12—14       | 55.87 | 100    | 23.57 | 14.08 | 98     |
| 1. X.—26. XI.   | N. Belt Sea       | 13—18     | 0               | 15—18       | 56.00 | 452    | 24.53 | 14.38 | 348    |
| 2. I.—9. IV.    | S. Little Belt    | c. 30     | 0               | 8—16        | 55.67 | 762    | 24.30 | 14.20 | 820    |
| 31. XI.         | N. Little Belt    | c. 25     | 0               | 9—11        | 55.97 | 134    | 23.68 | 14.23 | 30     |
| 31. XI.         | N. Little Belt    | c. 25     | 0               | 12—15       | 56.28 | 68     | 24.21 | 14.42 | 45     |
| 1.—3. XII.      | S. of Als         | c. 25     | 0               | 9—15        | 55.73 | 148    | 23.28 | 13.90 | 90     |
| 1.—3. XII.      | S. of Als         | c. 25     | 1               | 15—24       | 55.65 | 423    | 24.24 | 14.07 | 401    |

Table 51. Racial characters of commercial herring in Danish catches in the Baltic-Belt Seas area 1956

D = Drift-net; P = Pound net; T = Trawl

| Locality                    | Depth.<br>m. | Date                  | Gear | Maturity | Length,<br>cm. | V.S.  | Number | V.P.  | K <sub>2</sub> | Number |
|-----------------------------|--------------|-----------------------|------|----------|----------------|-------|--------|-------|----------------|--------|
| Skagerak                    |              |                       |      |          |                |       |        |       |                |        |
| Off Hirtshals . . . . .     | 30—132       | 24. I., 6. 2., 16. 2. | T    | I—II—III | 18—27          | 56.66 | 363    | 23.94 | 14.79          | 312    |
|                             |              |                       |      | IV—V—VI  | 22—29          | 56.4  | 15     | 23.8  | 14.93          | 14     |
|                             |              |                       |      | VII—VIII | 24—31          | 56.55 | 92     | 23.98 | 14.80          | 92     |
| N.N.W. of Skagen .          | 38—47        | 1. 7.                 | D    | II—III   | 26—31          | 56.59 | 32     | 24.41 | 14.21          | 28     |
|                             |              |                       |      |          | 27—32          | 56.55 | 89     | 24.19 | 14.53          | 83     |
|                             |              |                       |      |          | 26—32          | 56.53 | 81     | 24.30 | 14.26          | 76     |
| S. Kattegat                 |              |                       |      |          |                |       |        |       |                |        |
| North Seeland               |              | 21. 5., 24. 5.        | P    | I—VIII   | 18—28          | 56.03 | 297    | 23.71 | 14.10          | 295    |
| North Seeland               |              | 25. 9.                | P    | I—II     | 18—25          | 55.65 | 71     | 23.48 | 14.00          | 63     |
|                             |              |                       |      | III—VIII | 19—28          | 55.62 | 107    | 23.89 | 14.08          | 98     |
| Belt Sea—W. Baltic—Bornholm |              |                       |      |          |                |       |        |       |                |        |
| S.W. Fyn                    |              | 13. 6.                | P    | I—II     | 19—25          | 55.58 | 65     | 23.48 | 13.97          | 61     |
|                             |              |                       |      | III—VIII | 20—29          | 55.75 | 110    | 23.91 | 14.11          | 110    |
| Great Belt . . . . .        | c. 25        | 13. 11.               | T    | I—VIII   | 19—28          | 55.43 | 177    | 23.87 | 13.83          | 173    |
| N. Little Belt . . . . .    | c. 25        | 31. 10.               | T    | I—II     | 16—25          | 55.68 | 86     | 24.07 | 14.03          | 83     |
|                             |              |                       |      | III—VIII | 18—29          | 56.10 | 70     | 23.87 | 14.21          | 68     |
| S. of Als                   | c. 25        | 1. 11.—3. 11.         | T    | I        | 14—26          | 55.65 | 424    | 24.24 | 14.08          | 320    |
|                             |              |                       |      | II—III   | 20—25          | 55.68 | 44     | 23.75 | 13.87          | 47     |
|                             |              |                       |      | IV—V     | 20—28          | 55.83 | 54     | 23.54 | 14.08          | 59     |
|                             |              |                       |      | VII—VIII | 24—27          | 55.8  | 10     | 23.9  | 14.6           | 10     |
| W. of Bornholm . . .        | c. 45        | 4. 7.                 | D, T | I—VIII   | 21—28          | 55.42 | 106    | 23.86 | 13.88          | 104    |

Table 52. Length distribution ( $0/_{00}$ ) of commercial herring in Danish catches 1956

| Maturity                                         | Centimetres |       |       |       |       |       |       |       |       | Total |
|--------------------------------------------------|-------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|                                                  | 15—16       | 17—18 | 19—20 | 21—22 | 23—24 | 25—26 | 27—28 | 29—30 | 31—32 |       |
| Off Hirtshals, 24. I., 6. II., 16. II., 479 fish |             |       |       |       |       |       |       |       |       |       |
| I—II—III .....                                   | —           | 4     | 217   | 351   | 167   | 48    | 4     | —     | —     | 770   |
| IV—V—VI .....                                    | —           | —     | —     | —     | 8     | 8     | 8     | 8     | —     | 33    |
| VII—VIII .....                                   | —           | —     | —     | —     | 6     | 29    | 69    | 88    | 4     | 196   |
| Total .....                                      | —           | 4     | 217   | 351   | 181   | 85    | 81    | 96    | 4     | 999   |
| N.N.W. of Skagen, 1. VII., 185 fish              |             |       |       |       |       |       |       |       |       |       |
| I—III .....                                      | —           | —     | —     | —     | —     | 17    | 67    | 94    | 6     | 184   |
| V—VI .....                                       | —           | —     | —     | —     | —     | —     | 144   | 339   | 28    | 511   |
| VII—VIII .....                                   | —           | —     | —     | —     | —     | 11    | 89    | 194   | 11    | 305   |
| Total .....                                      | —           | —     | —     | —     | —     | 28    | 300   | 627   | 45    | 1000  |
| Coast of North Seeland, 21. V., 24. V., 360 fish |             |       |       |       |       |       |       |       |       |       |
| I—II .....                                       | —           | 3     | 44    | 83    | 19    | —     | —     | —     | —     | 149   |
| III .....                                        | —           | —     | 64    | 272   | 47    | —     | —     | —     | —     | 383   |
| IV .....                                         | —           | —     | 6     | 144   | 31    | 17    | —     | —     | —     | 198   |
| V—VI .....                                       | —           | —     | 6     | 53    | 64    | 75    | 19    | —     | —     | 217   |
| VII—VIII .....                                   | —           | —     | —     | 3     | 28    | 17    | —     | 3     | —     | 51    |
| Total .....                                      | —           | 3     | 120   | 555   | 189   | 109   | 19    | 3     | —     | 998   |
| Coast of North Seeland, 25. IX., 181 fish        |             |       |       |       |       |       |       |       |       |       |
| I .....                                          | 6           | 17    | 39    | 50    | 6     | —     | —     | —     | —     | 118   |
| II .....                                         | —           | 6     | 39    | 116   | 88    | 33    | —     | —     | —     | 282   |
| III—IV .....                                     | —           | —     | 22    | 39    | 50    | 50    | 11    | —     | —     | 172   |
| V—VI .....                                       | —           | 6     | 94    | 94    | 44    | 50    | 17    | —     | —     | 305   |
| VII—VIII .....                                   | —           | —     | —     | 17    | 55    | 44    | 6     | —     | —     | 122   |
| Total .....                                      | 6           | 29    | 194   | 316   | 243   | 177   | 34    | —     | —     | 999   |
| Coast of S.W. Fyn, 13. VI., 180 fish             |             |       |       |       |       |       |       |       |       |       |
| I—II .....                                       | —           | —     | 67    | 167   | 111   | 22    | —     | —     | —     | 367   |
| III .....                                        | —           | —     | 11    | 17    | 94    | 83    | 6     | —     | —     | 211   |
| IV—V—VI .....                                    | —           | —     | 11    | 50    | 6     | 28    | 11    | —     | —     | 106   |
| VII—VIII .....                                   | —           | —     | 6     | —     | 56    | 205   | 44    | 6     | —     | 317   |
| Total .....                                      | —           | —     | 95    | 234   | 267   | 338   | 61    | 6     | —     | 1001  |
| Great Belt, 13. XI., 181 fish                    |             |       |       |       |       |       |       |       |       |       |
| I—II .....                                       | —           | —     | 77    | 271   | 99    | 17    | —     | —     | —     | 464   |
| III—IV—V .....                                   | —           | —     | 22    | 116   | 88    | 0     | 6     | —     | —     | 232   |
| VII—VIII .....                                   | —           | —     | 17    | 105   | 94    | 72    | 17    | —     | —     | 305   |
| Total .....                                      | —           | —     | 116   | 492   | 281   | 89    | 23    | —     | —     | 999   |
| W. of Bornholm, 4. VII., 109 fish                |             |       |       |       |       |       |       |       |       |       |
| I—I—III .....                                    | —           | 9     | —     | 92    | 211   | 28    | —     | —     | —     | 340   |
| V—VI .....                                       | —           | —     | —     | —     | —     | 9     | 18    | —     | —     | 27    |
| VII—VIII .....                                   | —           | —     | —     | 37    | 339   | 248   | 9     | —     | —     | 633   |
| Total .....                                      | —           | 9     | —     | 129   | 550   | 285   | 27    | —     | —     | 1000  |

autumn spawners from the western North Sea. In September—November the smaller fish of the 1-ringed group were mostly North Sea autumn spawners, no doubt somewhat mixed with Kobbergrund herring, to which group almost all the larger 1-ringed fish belonged.

## 2. The Belt Sea and western Baltic

Most of the catches of small herring consisted of local autumn spawners, as in 1955 (see Table 50). In the samples from the northern Belt Sea they were coastal-spawning autumn herring from the northern part of the Belt Sea or Kattegat, in the autumn somewhat mixed with other races. In these samples the few fish of 7—11 cm. length were pure Kobbergrund herring, but the herring of more than 12 cm. length were mixed with local spring spawners. In two samples from 11. and 26. November the herring of 12—14 cm. length were almost

pure spring spawning fish with lower V.P. and  $K_2$  counts. The above-mentioned admixture of local spring spawners is proved by the fact that the  $K_2$  in the herring over 12 cm. length was lower than what is characteristic for pure autumn spawners.

As shown in Table 50 the majority of the small herring caught in spring in the southern Little Belt were autumn spawners. Their racial characters show that they originated from the Belt Sea or the western Baltic.

It is a most important feature that the autumn spawning herring this year again have predominated among the young herring, because it promises that the autumn fishery for adult herring will recover in the next years after a more than 10-year period of poor fishing. In one sample taken in the northern Little Belt on 30. November and in some others from south of Als, taken in the first days of December, most of the 0-ringed herring were spring

Table 53. Age distribution ( $^0/_{00}$ ) of commercial herring in Danish catches 1956

| Maturity                                         | Number of rings |     |     |     |     |     |     |     |    |     | Total |
|--------------------------------------------------|-----------------|-----|-----|-----|-----|-----|-----|-----|----|-----|-------|
|                                                  | 1               | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9  | 10+ |       |
| Off Hirtshals, 24. I., 6. II., 16. II., 479 fish |                 |     |     |     |     |     |     |     |    |     |       |
| I-II-III .....                                   | 608             | 134 | 25  | 4   | 2   | —   | —   | —   | —  | —   | 773   |
| IV-V-VI .....                                    | —               | 15  | 2   | 2   | 4   | 2   | 4   | 2   | —  | —   | 31    |
| VII-VIII .....                                   | —               | 8   | 31  | 17  | 21  | 48  | 15  | 31  | 10 | 14  | 195   |
| Total .....                                      | 608             | 157 | 58  | 23  | 27  | 50  | 19  | 33  | 10 | 14  | 999   |
| N.N.W. of Skagen, 1. VII., 185 fish              |                 |     |     |     |     |     |     |     |    |     |       |
| II-III .....                                     | —               | —   | 6   | 22  | 17  | 44  | 44  | 44  | 6  | —   | 183   |
| V-VI .....                                       | —               | —   | —   | 11  | 56  | 183 | 183 | 67  | 6  | 6   | 512   |
| VII-VIII .....                                   | —               | —   | 11  | 11  | 33  | 117 | 105 | 22  | 6  | —   | 305   |
| Total .....                                      | —               | —   | 17  | 44  | 106 | 344 | 332 | 133 | 18 | 6   | 1000  |
| Coast of North Seeland, 21. V., 24. V., 360 fish |                 |     |     |     |     |     |     |     |    |     |       |
| I-II-III .....                                   | 136             | 369 | 36  | 3   | —   | —   | —   | —   | —  | —   | 544   |
| IV-VIII .....                                    | 106             | 144 | 92  | 69  | 25  | 17  | 3   | —   | —  | —   | 456   |
| Total .....                                      | 242             | 513 | 128 | 72  | 25  | 17  | 3   | —   | —  | —   | 1000  |
| Coast of North Seeland, 25. IX., 180 fish        |                 |     |     |     |     |     |     |     |    |     |       |
| I-IV .....                                       | 178             | 239 | 106 | 22  | 17  | —   | —   | —   | —  | —   | 562   |
| V-VIII .....                                     | 178             | 100 | 111 | 33  | 6   | 6   | 6   | —   | —  | —   | 440   |
| Total .....                                      | 356             | 339 | 217 | 55  | 23  | 6   | 6   | —   | —  | —   | 1002  |
| Coast of S.W. Fyn, 16. VI., 180 fish             |                 |     |     |     |     |     |     |     |    |     |       |
| I-II .....                                       | —               | 261 | 89  | 17  | 11  | —   | —   | —   | —  | —   | 378   |
| III-VIII .....                                   | —               | 106 | 222 | 200 | 44  | 33  | 11  | 6   | —  | —   | 622   |
| Total .....                                      | —               | 367 | 311 | 217 | 55  | 33  | 11  | 6   | —  | —   | 1000  |
| Great Belt, 13. XI., 181 fish                    |                 |     |     |     |     |     |     |     |    |     |       |
| I-II .....                                       | 177             | 204 | 39  | 22  | 22  | —   | —   | —   | —  | —   | 464   |
| III-VIII .....                                   | 77              | 177 | 133 | 72  | 44  | 28  | 6   | —   | —  | —   | 537   |
| Total .....                                      | 254             | 381 | 172 | 94  | 66  | 28  | 6   | —   | —  | —   | 1001  |
| W. of Bornholm, 4. VII., 109 fish                |                 |     |     |     |     |     |     |     |    |     |       |
| I-VIII .....                                     | —               | 37  | 101 | 413 | 339 | 83  | 28  | —   | —  | —   | 1001  |

spawners, but Kobbegrund herring seem also to be a component of the sample from November.

The larger immature fish were mainly ca. 2-year-old Belt Sea autumn spawners.

In 3 samples fished off Hirtshals in January—February 1956 the immature, young, spents, and recovering spents were North Sea autumn spawners (see Table 51). The few almost mature herring may have been coastal spring spawners from the North Sea.

In a sample taken N.N.W. of Skagen on 1. July half of the fish were almost mature North Sea autumn spawners. They are usually not found there during the summer in any great quantity, but the sample was unfortunately not large enough to determine to which part of the North Sea they belong; it may, however, be of interest to the discussion on the fluctuations in yield of some herring fisheries in the North Sea that shifts in the habitat of the almost mature herring (maturity stages IV-V-VI) occur.

The length and age distributions are shown in Tables 52 and 53.

The pound-net samples of adult herring taken in the southern Kattegat in May and south-west of

Fyn in June consisted mainly of 3—4-year-old local spring spawning coastal herring mixed with relatively many 2-year-old fish of the same race.

The autumn spawners caught in pound net at North Seeland in September were 3—4 years old, but two-fifths of the catch investigated were immature 2-ringed Belt Sea spring spawners.

In samples from the northernmost Little Belt caught by trawl on 31. October the immature herring (2-year-olds) were Belt Sea autumn spawners, but half of the catch consisted of maturing spring spawners from the northern Belt Sea or the southern Kattegat.

Immature trawl-caught herring from the northernmost Little Belt taken on 31. October and those taken south of Als at the beginning of November were 2-year-old Belt Sea autumn spawners, whereas the maturing herring which, by weight, constituted about half the yield of the fishery, were local spring spawners.

A sample from Bornholm in July consisted mostly of Baltic spring spawners.



# Preliminary Results of Swedish Herring Tagging Experiments in the Baltic

(Figures 18–21; Table 54)

In the years 1954–56 5,247 Baltic herring were tagged at the Swedish east coast, most of them in the Bothnian Sea. Up to 1. January 1957, 341 recoveries, or 6.5%, have been reported. The Lea hydrostatic tag was used. Most of the experiments were carried out in June and July. As far as known exclusively spring and summer spawning herring are included. Fish smaller than 16 cm. were tagged only in exceptional cases. The tagging technique is described by HANNERZ in Ann. Biol., XI, p. 157. In most cases the herring were liberated in the immediate vicinity of the place where the fish were caught.

The percentage of recovery from the different experiments has varied considerably, ranging from 1.3 to 17.0% in the first 12 months (see Table 54). The experiments in the northernmost part of the Gulf of Bothnia and Norra Kvarken have given the lowest values. This is in accordance with the short fishing period, the low fishing activity, and probably, with a sparser stock of fish in these areas, especially during the years in question. As the herring there is smaller than in the central Bothnian Sea the tagging mortality is presumably higher.

The great difference between the percentage recovery in the first year of the two experiments at Skatan in 1954 and 1955 might be explained by the hydrographic conditions. In 1955 the surface temperature was very high and the transition layer thin and, consequently, the herring did not

enter the shallowest water near the shore so frequently as in 1954. Thus in that year 56.6% of the recaptures were made with gwyniad and other wide-meshed nets (perch nets and others) in shallow areas, but in the 1955 experiment 28.3% only. The catch of herring with these wide-meshed nets is mainly an effect of the bridle and pin of the Lea tag.

The percentage caught with herring nets and traps during the first 12 months for these two experiments was 4.8 and 4.3%, respectively. The experiment at Stocka gave the highest figure for herring gears in this period, viz., 7.5%. These figures give of course only a very approximate idea of the real fishing mortality. The tagged fish is more easily entangled in the meshes of nets and traps than the non-tagged, the rate of tagging mortality is unknown, and so is the loss of tags. The selection of larger fish for tagging affects also the values.

In Figures 18–21 the recoveries from 4 different experiments are mapped. In 1954 at Skatan the herring were transported to Hundgrund about 10 naut. miles E.S.E. of Skatan. As the recaptures indicate, the majority of the herring, at least temporarily, returned to the coast in the neighbourhood of the original place of catching, and therefore the distance of transport has been omitted in estimating the migration distance along the coast.

No herring fishing is operated in greater distance than ca. 15 naut. miles off the coast and skerries in the Gulf of Bothnia and, accordingly, we have no recoveries from the open sea.

Table 54. Swedish Herring tagging in the Baltic in 1954–56

| Tagging locality <sup>1)</sup>                | Date               | Number tagged | % recovered (numbers in brackets) |                 |          |                 |          | Total up to 1. 1. 1957 |
|-----------------------------------------------|--------------------|---------------|-----------------------------------|-----------------|----------|-----------------|----------|------------------------|
|                                               |                    |               | 1954                              | After 12 months | 1955     | After 12 months | 1956     |                        |
| Norra Brändön, N.E. of Luleå                  | 15.—23. IX. 55     | 143           | —                                 | —               | 0.7 (1)  | 1.4 (2)         | 0.7 (1)  | 1.4 (2)                |
| Jävrebodarna, S. of Piteå                     | 27.—30. VI. 56     | 600           | —                                 | —               | —        | —               | 1.2 (7)  | 1.2 (7)                |
| Bjuren, S.E. of Umeå                          | 13.—19. VII. 55    | 548           | —                                 | —               | 0.9 (5)  | 1.3 (7)         | 0.7 (4)  | 1.6 (9)                |
| Bjuren, S.E. of Umeå                          | 4.—9. VII. 56      | 427           | —                                 | —               | —        | —               | 0.7 (3)  | 0.7 (3)                |
| Skatan, S.E. of Sundsvall                     | 3. VI.—1. VII. 54  | 500           | 10.6 (53)                         | 11.8 (59)       | 3.4 (17) | —               | 2.0 (10) | 16.0 (80)              |
| Skatan, S.E. of Sundsvall                     | 29. VI.—8. VII. 55 | 999           | —                                 | —               | 5.3 (53) | 6.5 (65)        | 3.5 (35) | 8.8 (88)               |
| Stocka, N. of Hudiksvall                      | 1.—9. IX. 55       | 318           | —                                 | —               | 9.8 (31) | 17.0 (54)       | 9.1 (29) | 18.9 (60)              |
|                                               | 4.—5. X. 55        |               | —                                 | —               | —        | —               | —        | —                      |
| Axmarby, N. of Gävle                          | 12.—15. VI. 56     | 599           | —                                 | —               | —        | —               | 4.0 (24) | 4.0 (24)               |
| Edholma, Vaxholm, N.E. of Stockholm           | 11.—26. V. 55      | 512           | —                                 | —               | 5.9 (30) | 5.9 (30)        | 0.4 (2)  | 6.3 (32)               |
| Baggensfjärden, Saltsjöbaden, E. of Stockholm | 28.—30. V. 56      | 261           | —                                 | —               | —        | —               | 7.3 (19) | 7.3 (19)               |
| Valdemarsviken, S.E. of Norrköping            | 21.—22. IV. 55     | 40            | —                                 | —               | 7.5 (3)  | 7.5 (3)         | —        | 7.5 (3)                |
| Gudingén, N. of Västervik                     | 20. VI.—2. VII. 55 | 300           | —                                 | —               | 2 (6)    | 4.7 (14)        | 2.7 (8)  | 4.7 (14)               |

<sup>1)</sup> arranged from north to south.



Figure 18

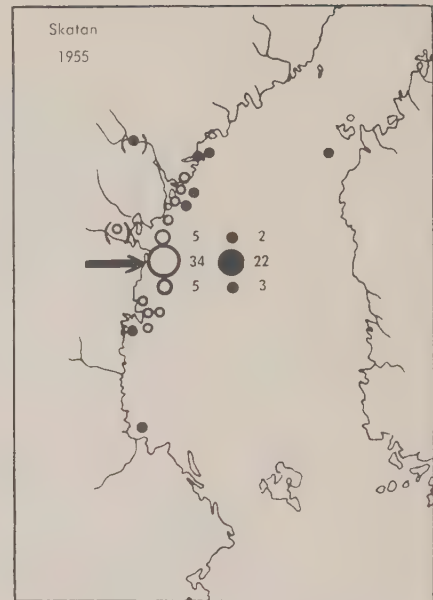


Figure 19

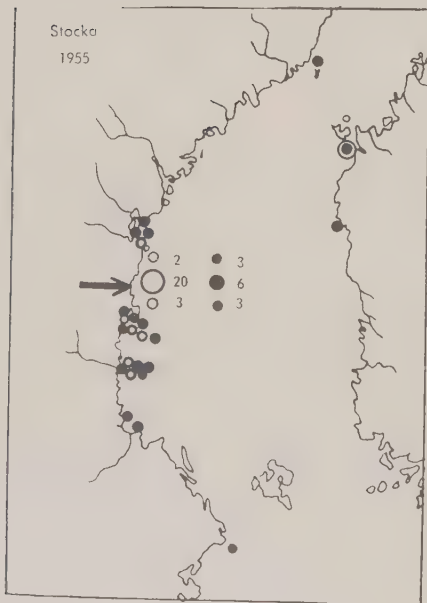


Figure 20



Figure 21

Figures 18-21. Recoveries from four herring tagging experiments in the Baltic. The tagging locality is indicated with an arrow. ○ — records in the year of tagging, ● — records in the next year, and ⊙ — records in the third year. Symbols in front of the arrows are the numbers of recoveries in a radius of 10 naut. miles; next above and below are the numbers of records in a distance of 10-20 naut. miles northwards and southwards, respectively. The rest of the recoveries are individually marked. Symbols in parenthesis (Fig. 19) indicate two herring found in the stomach of sea trout.

In general, the experiments have shown that the Baltic herring have more migratory habits than was earlier supposed. Exchange has been ascertained between the Swedish and Finnish side of the Bothnian Sea and between this area and the southern part of the Bothnian Bay in the north and south of the Åland Islands in the south. Herring from the central Baltic have been recovered off the coasts of Scania and Blekinge. On the other hand, several recaptures have been reported from the areas of tagging within the second or third year a fact which demonstrates returns, or even stationary habits. Recoveries in May—July from far away indicate, however, also that there sometimes is a shift of spawning area.

The result of the experiment at Stocka in autumn 1955 gives the impression that the herring fished there at this season are recruited from an area of considerable extension. The lack of recaptures in fair numbers in the vicinity of Stocka from the experiment at Skatan in the same year indicate that more or less separate herring populations inhabit the coast. The high number of returns in 1956 from the 1955 experiment in the tagging area at Skatan is also in favour of this view.

GUNNAR OTTERLIND

### Composition of the Herring Stock in the Southern Baltic

The trawl catches on the open-sea grounds in summer/autumn were characterized, as in former years, by the predominance of old herring. The age and length compositions of the spring herring predominating in this period are presented below:—

#### Length distribution (%)

|                | cm. 16 | 17   | 18   | 19   | 20  | 21   | 22   |
|----------------|--------|------|------|------|-----|------|------|
| Gdansk Region  | 0.2    | 1.6  | 4.6  | 7.1  | 8.8 | 13.3 | 20.6 |
| Bornholm Basin | 0.7    | 4.1  | 13.8 | 10.9 | 8.5 | 7.2  | 9.4  |
|                | cm. 23 | 24   | 25   | 26   | 27  | 28   |      |
| Gdansk Region  | 22.5   | 13.8 | 5.4  | 1.4  | 0.6 | 0.1  |      |
| Bornholm Basin | 11.4   | 15.0 | 11.6 | 6.0  | 0.7 | 0.7  |      |

#### Age distribution (%)

|                | Years 3 | 4    | 5    | 6   | 7    |
|----------------|---------|------|------|-----|------|
| Gdansk Region  | 1.2     | 4.2  | 9.0  | 7.7 | 13.5 |
| Bornholm Basin | 3.1     | 20.0 | 15.9 | 7.7 | 8.9  |
|                | Years 8 | 9    | 10   | 11  | 12+  |
| Gdansk Region  | 25.0    | 16.1 | 7.4  | 3.7 | 12.1 |
| Bornholm Basin | 11.6    | 14.7 | 4.6  | 3.4 | 9.9  |

In Gdansk Bay the most numerous year-classes were those of 1952, 1950, 1949, and 1948, but the now disappearing 1943 and 1944 year-classes were

predominant in the group of herring 12+ years old. Similar conditions were observed in the Bornholm Basin, the only difference being the presence, in great numbers, of the 1953 year-class.

Autumn herring were again plentiful after the serious drop in the years 1949—1954. The brood hatched in the autumn of 1952 seemed especially to be of greater strength than earlier broods. In accordance with this a definite rejuvenation of this stock, which in the years of depletion had been characterized by the predominance of the older age-groups, was observed.

The fat content of the herring was exceptionally low in 1956, and the coefficient K, after FULTON's formula, was the lowest since 1947. Likewise was the growth-rate low, the mean length of the 2-year-old spring herring ( $l_2$ ) in Gdansk Bay being about 15 cm., as compared with the 17 cm. length usually found in this region.

J. POPIEL

### Distribution of Pre-Spawning Spring Spawning Herring in Gdansk Bay in Relation to the Thermocline

(Figures 22–24)

The majority of the Baltic herring on the USSR side of Gdansk Bay are caught in pound nets. The catches are therefore entirely dependent on the herrings' shoreward migration in depths not exceeding 20 m. These migrations, especially the entry into the Bay of Vistula, depend on many factors of which the abundance of fish and the hydro-meteorologic conditions are of primary importance.

During the long delay caused by the unfavourable spring 1956 the herring accumulated in the centre of the bay in depths of 100 m. or more, as illustrated by echo-grams (Figure 22a and b) taken at the end of March. As early as April the accumulations commenced to spread over wider areas (Figure 23). Normally the herring enter the Bay of Vistula late in March.

It was observed that herring in late March in the day time stay in the bottom layers below the thermocline. This fact was most conspicuous in the Klaipeda area where the temperature differed by 4°C. in the water layers of 55 and 60 m. depth. Figure 24 shows how the dense shoals of herring lie close to the slope below the thermocline at a depth of 56 m. Later on, as the water was heating it was also possible to trace the herring concentrations by echo-sounding the mid-water layers in day time.

N. BIRYUKOV

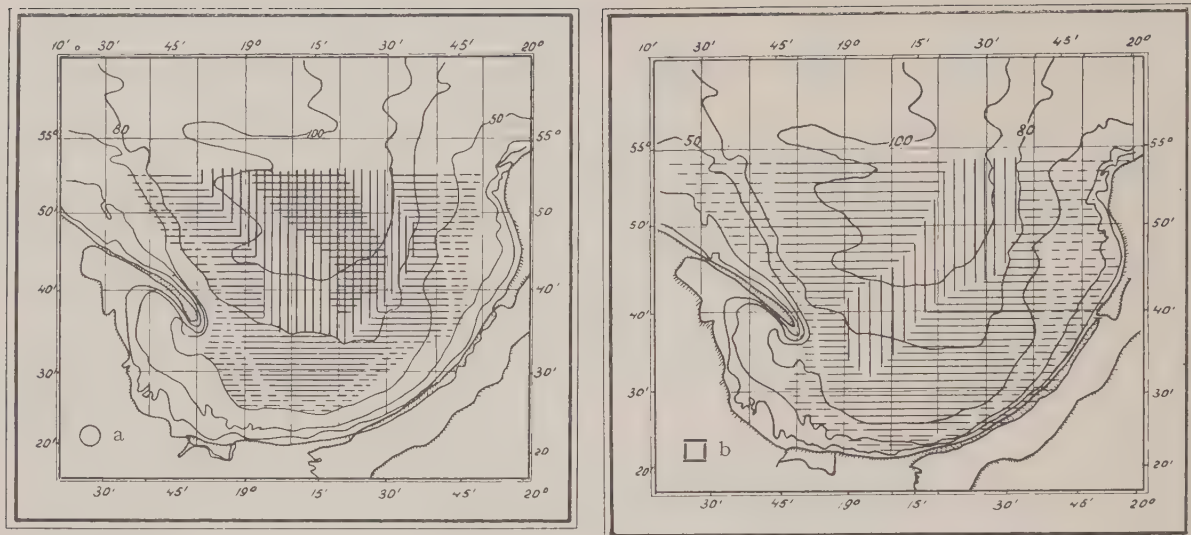


Figure 22. Distribution of herring shoals in Gdansk Bay in spring 1956. (a) 26.—27. March. (b) 6.—10. April.

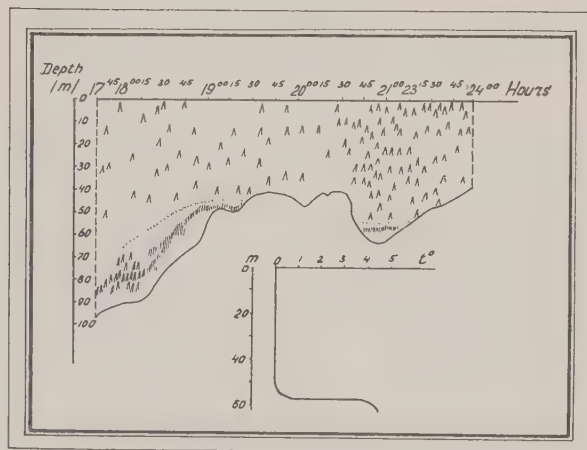


Figure 23. Distribution of herring shoals and water temperature in the region of Klaipeda at the end of March 1956.

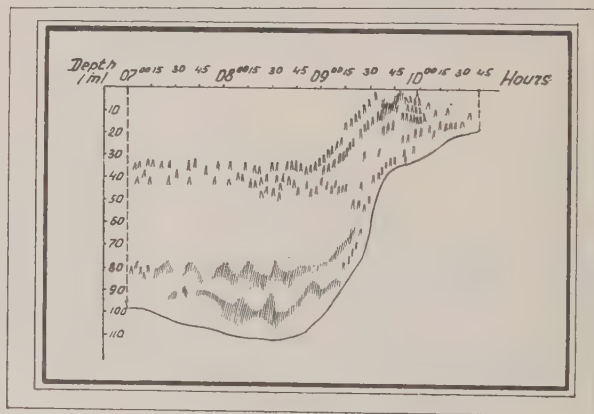


Figure 24. Distribution of herring in different water layers in relation to the heating of the water in Gdansk Bay, 18. April 1956.

## Age Composition and Numerical Strength of Spring Spawning Herring in the Bay of Vistula

(Tables 55–56)

The commercial stock of Baltic spring spawners has in recent years been recruited from comparatively poorer year-classes than in 1946—49. Starting in 1952 this has consequently resulted in smaller catches of herring in the Bay of Vistula. In 1956 the average catch per net was especially low in spite of a reduction in the number of pound nets (Table 55). Moreover were meteorological conditions also unfavourable.

Table 55. Catch per net of Baltic herring in the Bay  
of Vistula  
(in cwt.)

| Year       | Catch<br>(1000 cwt.) | Average number<br>of nets | Catch<br>per net |
|------------|----------------------|---------------------------|------------------|
| 1950 ..... | 177.3                | 176                       | 980              |
| 1951 ..... | 170.6                | 238                       | 680              |
| 1952 ..... | 138.9                | 205                       | 610              |
| 1953 ..... | 98.0                 | 161                       | 500              |
| 1954 ..... | 106.2                | 154                       | 700              |
| 1955 ..... | 38.9                 | 132                       | 300              |
| 1956 ..... | 18.0                 | 90                        | 200              |



Table 56. Age composition of spring spawning herring in the Bay of Vistula (%)

| Year       | Age |      |      |      |     |     |
|------------|-----|------|------|------|-----|-----|
|            | 1   | 2    | 3    | 4    | 5   | 6-7 |
| 1950 ..... | —   | 20.5 | 19.6 | 54.0 | 5.3 | 0.6 |
| 1951 ..... | —   | 23.0 | 53.7 | 20.7 | 2.6 | —   |
| 1952 ..... | 2.4 | 27.0 | 40.4 | 25.1 | 4.6 | 0.5 |
| 1953 ..... | 1.1 | 20.4 | 40.0 | 29.9 | 7.6 | 1.0 |
| 1954 ..... | 0.7 | 48.7 | 35.5 | 11.0 | 3.5 | 0.6 |
| 1955 ..... | 2.8 | 27.4 | 58.5 | 8.5  | 1.8 | 1.0 |
| 1956 ..... | —   | 45.0 | 34.0 | 19.0 | 1.8 | 0.2 |

The decrease in catches is accompanied by changes in age composition of the stock. The catches during later years have thus been composed chiefly of 2-year-olds while 3- and 4-year-olds dominated in 1950—53 (Table 56). Older year-classes do not enter the Bay of Vistula for spawning.

The average length of the herring in the Bay of Vistula has increased somewhat in recent years as shown by the following table:—

|                         | Year    |      |      |
|-------------------------|---------|------|------|
|                         | 1950—56 | 1955 | 1956 |
| Average length, cm. ... | 17.8    | 18.1 | 18.9 |

The increase in length is accounted for by the predominance of a fast-growing race which is approaching Gdansk and Vistula Bays from the west.

A. SELETSKAJA

### Age Composition of Herring in the Gulf of Pärnu in Spring 1956

(Tables 57—58)

In 1956 the catches of spring spawning herring in the Gulf of Pärnu consisted mainly of 3-year-olds (1953 year-class), though 2-year-olds usually predominate in this gulf. In the Gulf of Riga proper the bulk of catches of spring spawners consists of 3-year-olds with 4-year-olds and older predominating in areas nearer the open sea.

The predominance of the 1953 year-class in the Gulf of Pärnu denotes the greater strength of this brood in comparison with those of 1952 (4-year-olds) and 1954 (2-year-olds), (Table 57). The com-

Table 57. Age composition of spring spawners in the Gulf of Pärnu (%)

| Year         | Age |      |      |      |     |     |
|--------------|-----|------|------|------|-----|-----|
|              | 1   | 2    | 3    | 4    | 5   | 6   |
| 1956 .....   | 0.4 | 42.6 | 47.2 | 5.5  | 4.0 | 0.2 |
| 1947—56 .... | 0.6 | 43.9 | 32.4 | 15.8 | 4.2 | 0.9 |

bination of one abundant and two poor year-classes, added to unfavourable hydrographic conditions hindering the shoreward spawning migration, caused a decline in the catches of herring in the Gulf of Riga in spring 1956.

The quantitative estimation of larvae in the northern part of the Gulf of Riga made it possible to anticipate the strength of the broods composing the commercial catches in spring 1956.

Such estimates have been made regularly since 1947 (except in 1950 and 1953). Comparison with data on the age composition of catches showed the development of poor year-classes in years when the quantity of larvae in the samples was insignificant (see Table 58). High yields of Baltic spring spawners were obtained in the northern part of the Gulf of Riga in 1955 and 1956. Occurrence of abundant year-classes is concurrent with years of intensive zooplankton production.

Table 58. The quantity of larvae of Baltic spring spawners per 10 m.<sup>3</sup> of filtered water in the northern part of the Gulf of Riga and numerical strength of year-classes estimated from commercial catches in 1947—56

( ) = Gulf of Pärnu

| Year            | Larvae   |        | Brood strength |
|-----------------|----------|--------|----------------|
|                 | "Hansen" | "Russ" |                |
|                 | net      | net    | %              |
| 1947 .....      | 0.6      | 2.4    | 8.5            |
| 1948 .....      | 1.8      | 3.6    | 12.4           |
| 1949 .....      | 2.2      | 4.4    | 17.0           |
| 1950 .....      | —        | —      | 0.1            |
| 1951 .....      | 5.2      | 6.7    | 15.0           |
| 1952 .....      | —        | —      | 4.3            |
| 1953 .....      | 2.7      | 3.1    | 12.0           |
| 1954 .....      | 1.8      | 2.7    | (7.7)          |
| 1955 .....      | 8.3      | 3.3    | (14.0)         |
| 1956 .....      | 8.3      | 8.3    |                |
| 1947—1956 ..... | 3.7      | 4.3    | 100.0          |

L. RANNAK

# Sardine

## INTRODUCTION

Contributions to this report have been received from the following countries: —

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## COMMERCIAL FISH

### Sardine

#### Composition du Stock en 1956 dans la Région de La Rochelle

(Figures 1-2, Tableaux 1-3)

En 1956, 873 sardines ont été examinées au laboratoire de La Rochelle pour étudier l'évolution du stock présent sur les pêcheries entre l'île d'Oléron et les Sables d'Olonne de Mai à Juin et de Septembre à Novembre.

Ces observations peuvent se résumer ainsi:—

**Groupe I.** En Mai—Juin on trouve des sardines à moyenne vertébrale élevée (52.39 et 52.44) où l'on reconnaît le type armoricain à forte valeur de  $L_1$  (88 mm.). Ces sardines, de taille modale comprise entre 130 et 140 mm., sont accompagnées de sardines plus petites (120—125 mm.) et à moyenne vertébrale plus faible (52.21 et 52.16) mais toujours assimilables au type armoricain.

On pêche encore en Octobre des sardines de mêmes caractères avec une taille modale de 150 mm. et une moyenne vertébrale de 52.20 (taille à  $L_1$  = 82 mm.).

En Septembre—Octobre on ne capture pratiquement plus que des sardines de type aquitain, de

taille modale 130 à 140 mm., caractérisées par leur faible taille à  $L_1$  de 66 mm. et leur moyenne vertébrale également faible. Le chiffre de 52.11 trouvé sur ces poissons dénote cependant le léger mélange déjà signalé avec le type précédent et nettement observé dans le lot d'Octobre.

En Novembre les sardines aquitaniennes se rencontrent seules sur la pêcherie avec la moyenne vertébrale très caractéristique de 52.07.

**Groupe 0.** Un groupe 0 était très faiblement représenté dans notre échantillonnage de Juin à Novembre mais le nombre des observations est trop réduit pour obtenir une moyenne vertébrale caractéristique.

En Octobre, sur 17 individus, nous avons bien trouvé une moyenne de 51.94 proche de celle du groupe cantabrique (51.80) observé régulièrement les années antérieures. Par contre, PERCIER sur le "Donibane" a observé en été un abondant groupe 0 (taille modale 95 mm.) présent sur la côte landaise avec une moyenne vertébrale de 52.26 typiquement armoricaine.

Malgré ces indications il ne nous est cependant pas possible de préciser l'origine du groupe 0 rencontré dans notre région.

Tableau 1. Tailles observées

| mm. | Groupes | Mai  | Juin |      |      | Septembre |      |     | Octobre |     |   | Novembre |    |    |
|-----|---------|------|------|------|------|-----------|------|-----|---------|-----|---|----------|----|----|
|     |         | I    | 0    | I    | I    | 0         | I    |     | 0       | I   | I | 0        | I  | II |
| 100 | .....   | 1    | —    | —    | —    | —         | —    | —   | —       | —   | — | —        | —  | —  |
| 5   | .....   | 1    | —    | —    | —    | —         | —    | —   | —       | —   | — | —        | —  | —  |
| 110 | .....   | 2.5  | —    | —    | —    | —         | —    | —   | 0.5     | —   | — | —        | —  | —  |
| 5   | .....   | 15.5 | —    | —    | —    | —         | —    | —   | 0.5     | —   | — | —        | —  | —  |
| 120 | .....   | 18   | —    | —    | 2.5  | —         | —    | —   | 2.5     | —   | — | —        | —  | —  |
| 5   | .....   | 7.5  | —    | 5.5  | 12   | —         | 1    | —   | 1.5     | —   | — | —        | —  | —  |
| 130 | .....   | 7.5  | —    | 33.5 | 9    | 0.5       | 17.5 | 0.5 | 3.5     | —   | — | 1        | —  | —  |
| 5   | .....   | 8.5  | 2.5  | 32   | —    | 0.5       | 59   | 0.5 | 25      | —   | — | 2        | 9  | —  |
| 140 | .....   | 23   | 1.5  | 1.5  | —    | 1         | 17.5 | —   | 34      | —   | — | 3        | 56 | —  |
| 5   | .....   | 11.5 | —    | —    | —    | —         | 1.5  | —   | 12.5    | —   | — | 1        | 25 | —  |
| 150 | .....   | 4    | —    | —    | —    | —         | 1    | —   | —       | 5   | — | —        | 1  | —  |
| 5   | .....   | —    | —    | —    | —    | —         | 0.5  | —   | —       | 6   | — | —        | —  | —  |
| 160 | .....   | —    | —    | —    | —    | —         | —    | —   | —       | —   | — | —        | —  | —  |
| 5   | .....   | —    | —    | —    | —    | —         | —    | —   | —       | 4   | — | 1        | —  | —  |
| 170 | .....   | —    | —    | —    | —    | —         | —    | —   | —       | 3   | — | —        | —  | —  |
| 5   | .....   | —    | —    | —    | —    | —         | —    | —   | —       | 0.5 | — | —        | —  | —  |
|     | .....   | —    | —    | —    | —    | —         | —    | —   | —       | 0.5 | — | —        | —  | —  |
| %   | .....   | 100  | 4    | 72.5 | 23.5 | 2         | 98   | 6   | 75      | 19  | 7 | 92       | 1  |    |
| N   | .....   | 117  |      | 75   |      |           | 304  |     | 277     |     |   | 100      |    |    |

A notre avis ces observations indiquent, que, sans être redevenue tout à fait normale, la composition du stock de sardines a été nettement plus satisfaisante en 1956 qu'au cours des années précédentes.

En effet, le groupe 0 armoricain qui a pratiquement disparu dans nos observations depuis 1950 ne fournit plus une partie de la pêche d'Octobre—Novembre comme il le faisait alors.

Le groupe I aquitain, également déficitaire ou absent depuis 1950, a reparu en 1956 en quantité importante et a normalement remplacé le groupe I armoricain sur les pêcheries, évitant ainsi la chute des apports constatée ces dernières années à partir du mois d'Août.

En ce qui concerne le groupe I armoricain, il a été, semble-t-il, aussi bien représenté que les années antérieures mais composé en Mai d'individus répondant à deux tailles modales très nettement différentes. La première (140 mm.) correspond à la moyenne des observations effectuées dans la région. La seconde par contre (120 mm.) n'a

Tableau 2. Tailles à  $L_1$ 

| mm. | Juin | Septembre | Octobre | Novembre |
|-----|------|-----------|---------|----------|
| 5   | —    | —         | 0.5     | —        |
| 50  | —    | —         | 1.5     | 4        |
| 5   | —    | 3.5       | 5       | 7.5      |
| 60  | —    | 16        | 12.5    | 23.5     |
| 5   | —    | 31        | 22.5    | 23.5     |
| 70  | —    | 33.5      | 27      | 29.5     |
| 5   | 1.5  | 9.5       | 12      | 5.5      |
| 80  | 22   | 5.5       | 8.5     | 2        |
| 5   | 15   | 0.5       | 5       | 1.5      |
| 90  | 38   | —         | 2.5     | 1.5      |
| 5   | 11   | 0.5       | 2       | —        |
| 100 | 12.5 | —         | 0.5     | —        |
| 5   | —    | —         | —       | —        |
| 110 | —    | —         | —       | 1.5      |
| 5   | —    | —         | —       | —        |
| 120 | —    | —         | 0.5     | —        |
| N   | 72   | 185       | 218     | 91       |

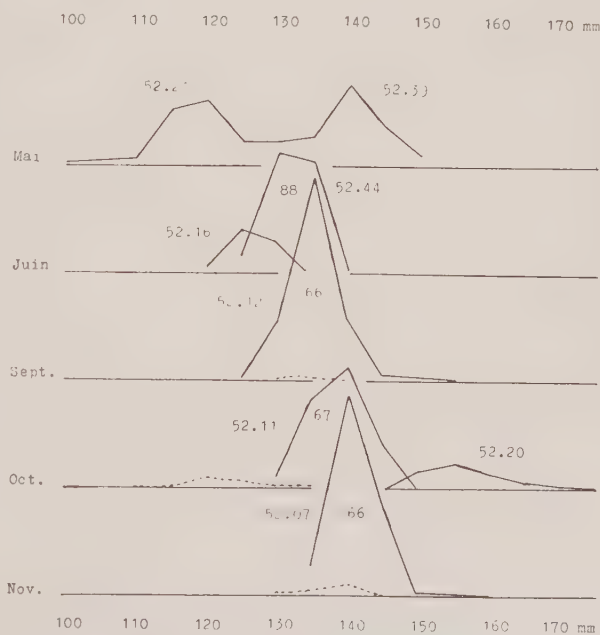


Figure 1. Tailles observées en millimètres avec moyenne vertébrale (52.07) et taille à  $L_1$  (67).  
Pointillé = Groupe 0. Trait plein = Groupe I.

Tableau 3. Moyenne vertébrale

| Groupes       | Mai   |       | Juin |       |       | Septembre |       | Octobre |       |       | Novembre |       |    |
|---------------|-------|-------|------|-------|-------|-----------|-------|---------|-------|-------|----------|-------|----|
|               | I     |       | 0    | I     | I     | 0         | I     | 0       | I     | I     | 0        | I     | II |
| Vertèbres     | ar    |       |      | ar    |       | aq        |       | aq      |       | ar    | aq       |       |    |
| 50 .....      | 3     | —     | —    | —     | —     | —         | —     | —       | 2     | —     | —        | —     | —  |
| 51 .....      | 3     | 7     | I    | I     | 2     | —         | 26    | 4       | 21    | 3     | —        | 13    | —  |
| 52 .....      | 31    | 26    | I    | 29    | 11    | 2         | 111   | 10      | 116   | 22    | 6        | 59    | —  |
| 53 .....      | 17    | 25    | I    | 23    | 5     | 2         | 47    | 3       | 46    | 10    | I        | 20    | I  |
| 54 .....      | 2     | 3     | —    | I     | —     | —         | I     | —       | —     | —     | —        | —     | —  |
| N .....       | 56    | 61    | 3    | 54    | 18    | 4         | 185   | 17      | 185   | 35    | 7        | 92    | I  |
| Moyenne ..... | 52.21 | 52.39 |      | 52.44 | 52.16 |           | 52.12 | 51.94   | 52.11 | 52.20 |          | 52.07 |    |

été observée qu'en Juin 1946 avec une moyenne vertébrale identique de 52.22. Elle est à rapprocher des observations faites en 1941 et 1942 sur la côte des Landes par FURNESTIN sur des individus à moyenne vertébrale également semblable (52.28 et 52.24).

Sans pouvoir attribuer à cette dernière remarque une importance particulière, il est cependant possible d'affirmer qu'en 1956 le stock de sardines a, pour la première fois depuis 6 ans, retrouvé une composition à peu près normale, ce qui s'est traduit par d'excellents apports sur les pêcheries du centre du Golfe de Gascogne.

Cette constatation met en évidence le rôle prédominant joué dans la pêche d'été par le groupe I aquitainien. Si cette situation se confirme et s'améliore encore en 1957 par une reprise de l'abondance du groupe 0 armoricain en fin de saison, on peut penser que la pêche d'hiver dans le sud du Golfe ira également en s'améliorant et que les campagnes sardinières seront de nouveau plus normales au cours des années à venir.

R. LETACONNOUX

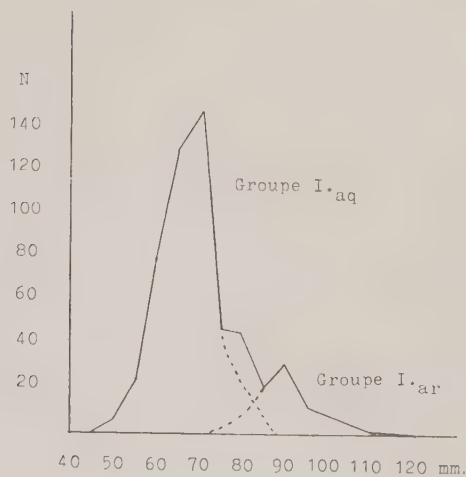


Figure 2. Tailles à  $L_1$ .

## La Sardine de la Côte du Portugal en 1955—1956

(Figures 3-5; Tableau 4)

La production totale a été de 81,982 tonnes en 1955 et de 91,408 tonnes en 1956, les chiffres suivants correspondant aux trois ports où se réalisent les observations:—

|                | 1955   | 1956   |
|----------------|--------|--------|
| Leixoes .....  | 40,157 | 45,509 |
| Lisbonne ..... | 2,642  | 5,541  |
| Portimão ..... | 30,686 | 36,170 |
| Totale .....   | 81,982 | 91,408 |

### Matériel recueilli

Les observations ont été poursuivies, suivant la routine des années précédentes, à:

1) Leixoes (observateur, J. MACHADO CRUZ, au Laboratoire de Zoologie Maritime de l'Université de Porto) sur échantillons journaliers, avec un total de 17,798 sardines, recueillis en 1956 à partir du mois d'Avril. 2) Lisbonne (observateurs, A. M. RAMALHO, J. PINTO, I. BARRACA, M. C. AZEVEDO e SILVA, P. GRAÇA) sur 50 échantillons hebdomadaires comprenant 6,837 sardines en 1955, et sur 33 échantillons, aussi hebdomadaires, comprenant 5,966 sardines en 1956. 3) Portimao (observateur, J. LUIS, à l'usine de conserves de sardines de M. António Feu) sur échantillons journaliers comprenant 21,300 sardines en 1955 et 20,474 sardines en 1956.

### Taille

La longueur que nous mesurons est celle comprise entre le bout du museau et la fourche de la nageoire caudale; elle correspond à 0.90 de la longueur totale, caudale comprise.

La Figure 3 montre la distribution des tailles, groupées par classes de 0.5 cm. et en ‰ des totaux mensuels. Les valeurs sont enregistrées dans le Tableau 4.

En ce qui concerne les échantillons de Leixoes, les sardines de la classe 0 (génération de 1956) apparaissent pour la première fois, dans le produit de la pêche, en Juillet; à partir de cette date on note une prédominance très nette de cette classe 0,



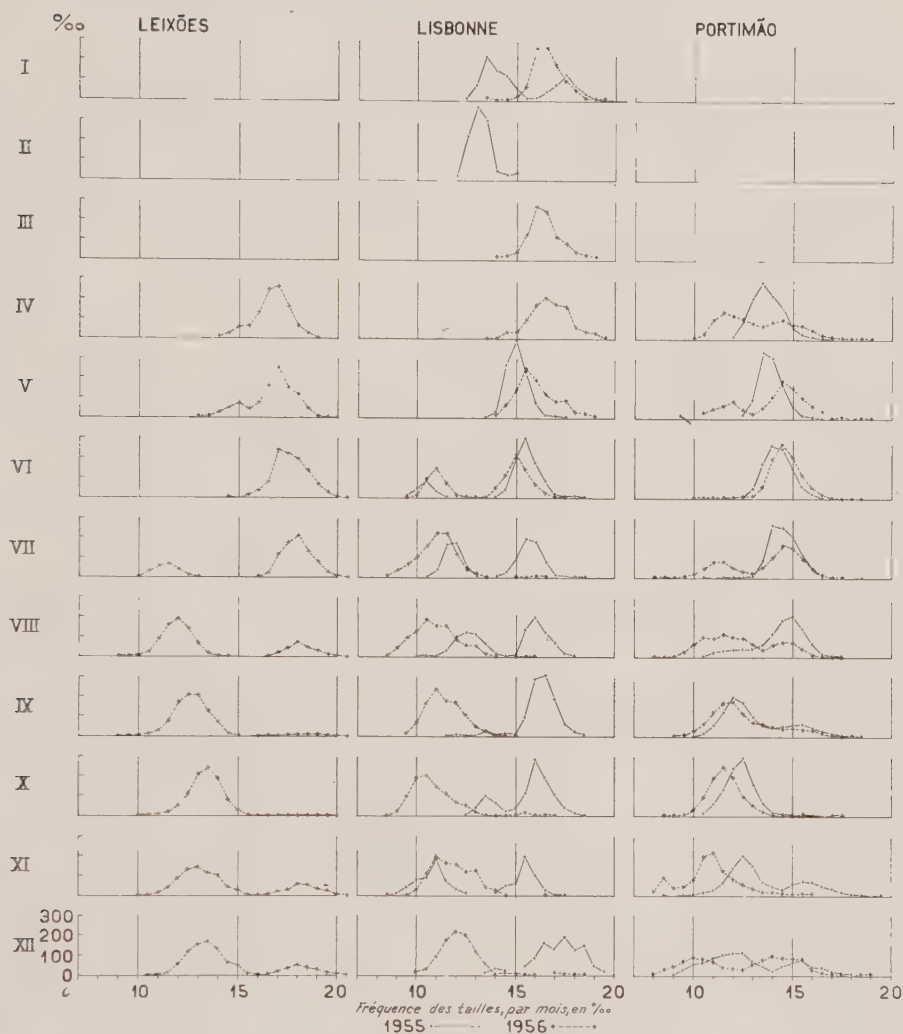


Figure 3. Fréquence des tailles, par mois, en ‰.

1955 ———; 1956 - - - - -

les sardines de la classe I étant très rares dans les échantillons.

A Lisbonne, les sardines de la classe 0, en 1955 et en 1956 (générations de 1955 et de 1956), apparaissent pour la première fois en Juin. Dans les mois ultérieurs, toutefois, la représentation des deux principales classes d'âge, 0 et I, n'est pas équivalente dans les deux années; en 1955, où prédominent nettement les sardines de la classe I (Juin, Septembre, Octobre, Décembre), les deux classes ont une représentation presque équivalente (Juillet, Août, Novembre). Cette alternance, selon notre avis, ne traduit pas la véritable composition des stocks naturels et doit résulter de facteurs agissant sur la composition initiale des échantillons.

En 1956, en exceptant le mois de Juin, où la classe I est représentée par un nombre d'exemplaires presque égal à celui de l'année précédente, on note, dans les mois ultérieurs, une prédominance de la classe 0, semblable à celle qui a été constatée à Leixões la même année.

La Figure 4 montre, sous forme de graphiques, les résultats des observations faites à Lisbonne pendant les hivers de 1954—55 et 1955—56 sur la caractérisation des classes d'âge 0, I et II, au point de vue de la taille. Pour la détermination de l'âge on a suivi la méthode déjà indiquée dans les rapports antérieurs. Les graphiques de la moitié gauche de la figure représentent les fréquences des tailles observées, par classes de demi-centimètres et en

Tableau 4. Taille à L<sub>1</sub> (cm.) par mois et en pourcentages

L = longueur; N = nombre d'exemplaires observés

| Leixoes |   |    |     |     |       |     |       |       |       |       |       |       |
|---------|---|----|-----|-----|-------|-----|-------|-------|-------|-------|-------|-------|
| 1956    |   |    |     |     |       |     |       |       |       |       |       |       |
| L       | I | II | III | IV  | V     | VI  | VII   | VIII  | IX    | X     | XI    | XII   |
| 8.0     | — | —  | —   | —   | —     | —   | —     | —     | —     | —     | —     | —     |
| .5      | — | —  | —   | —   | —     | —   | —     | —     | —     | —     | —     | —     |
| 9.0     | — | —  | —   | —   | —     | —   | —     | 4     | 2     | —     | —     | —     |
| .5      | — | —  | —   | —   | —     | —   | —     | 9     | 3     | —     | —     | —     |
| 10.0    | — | —  | —   | —   | —     | —   | 5     | 11    | 5     | 2     | 3     | —     |
| .5      | — | —  | —   | —   | —     | —   | 34    | 28    | 14    | 8     | 8     | 1     |
| 11.0    | — | —  | —   | —   | —     | —   | 63    | 95    | 29    | 12    | 19    | 8     |
| .5      | — | —  | —   | —   | —     | —   | 69    | 163   | 79    | 22    | 42    | 15    |
| 12.0    | — | —  | —   | —   | —     | —   | 39    | 199   | 172   | 51    | 89    | 52    |
| .5      | — | —  | —   | —   | —     | —   | 13    | 143   | 210   | 112   | 135   | 120   |
| 13.0    | — | —  | —   | —   | 3     | —   | 1     | 70    | 208   | 212   | 142   | 152   |
| .5      | — | —  | —   | —   | 5     | —   | —     | 17    | 130   | 243   | 117   | 172   |
| 14.0    | — | —  | —   | 10  | 26    | —   | —     | 5     | 64    | 189   | 105   | 132   |
| .5      | — | —  | —   | 25  | 49    | 2   | —     | 1     | 15    | 85    | 45    | 65    |
| 15.0    | — | —  | —   | 52  | 69    | —   | —     | —     | 3     | 29    | 27    | 50    |
| .5      | — | —  | —   | 58  | 42    | 12  | —     | —     | —     | 2     | 8     | 13    |
| 16.0    | — | —  | —   | 127 | 76    | 33  | 5     | —     | 1     | 1     | 3     | 5     |
| .5      | — | —  | —   | 240 | 157   | 78  | 22    | 5     | 4     | 2     | 10    | 8     |
| 17.0    | — | —  | —   | 252 | 250   | 235 | 118   | 23    | 3     | 3     | 23    | 21    |
| .5      | — | —  | —   | 153 | 150   | 220 | 175   | 48    | 9     | 6     | 29    | 37    |
| 18.0    | — | —  | —   | 60  | 117   | 190 | 211   | 74    | 10    | 5     | 58    | 52    |
| .5      | — | —  | —   | 22  | 47    | 136 | 130   | 49    | 14    | 6     | 56    | 39    |
| 19.0    | — | —  | —   | 1   | 6     | 62  | 78    | 34    | 12    | 7     | 36    | 28    |
| .5      | — | —  | —   | —   | 2     | 25  | 28    | 15    | 7     | 2     | 28    | 15    |
| 20.0    | — | —  | —   | —   | 1     | 5   | 8     | 6     | 5     | 1     | 11    | 11    |
| .5      | — | —  | —   | —   | —     | 2   | 1     | 1     | 1     | —     | 6     | 4     |
| N       | — | —  | —   | 600 | 1,000 | 600 | 2,400 | 2,600 | 2,900 | 2,700 | 2,798 | 2,200 |

| Lisbonne |     |     |     |    |     |     |       |       |     |     |     |     |
|----------|-----|-----|-----|----|-----|-----|-------|-------|-----|-----|-----|-----|
| 1955     |     |     |     |    |     |     |       |       |     |     |     |     |
| L        | I   | II  | III | IV | V   | VI  | VII   | VIII  | IX  | X   | XI  | XII |
| 8.0      | —   | —   | —   | —  | —   | —   | —     | —     | —   | —   | —   | —   |
| .5       | —   | —   | —   | —  | —   | —   | —     | —     | —   | —   | —   | —   |
| 9.0      | —   | —   | —   | —  | —   | —   | —     | —     | —   | —   | 16  | —   |
| .5       | —   | —   | —   | —  | —   | 12  | —     | —     | —   | —   | 48  | —   |
| 10.0     | —   | —   | —   | —  | —   | 46  | —     | 1     | —   | —   | 81  | —   |
| .5       | —   | —   | —   | —  | —   | 81  | 3     | 2     | —   | —   | 93  | —   |
| 11.0     | —   | —   | —   | —  | —   | 31  | 34    | 5     | —   | —   | 185 | —   |
| .5       | —   | —   | —   | —  | —   | 7   | 164   | 30    | 1   | —   | 73  | —   |
| 12.0     | —   | 16  | —   | —  | —   | —   | 169   | 98    | 3   | —   | 32  | —   |
| .5       | 8   | 219 | —   | —  | —   | —   | 49    | 124   | 1   | 6   | 12  | —   |
| 13.0     | 75  | 367 | —   | —  | —   | —   | 10    | 110   | 3   | 39  | —   | —   |
| .5       | 218 | 297 | —   | —  | 1   | —   | —     | 67    | 21  | 100 | —   | 8   |
| 14.0     | 148 | 39  | —   | —  | 25  | 1   | 2     | 18    | 8   | 63  | 16  | 33  |
| .5       | 120 | 23  | —   | —  | 262 | 39  | 25    | 5     | 11  | 23  | 52  | 17  |
| 15.0     | 58  | 31  | —   | —  | 386 | 201 | 92    | 9     | 8   | 34  | 60  | —   |
| .5       | 10  | —   | —   | —  | 230 | 299 | 189   | 130   | 92  | 109 | 195 | 41  |
| 16.0     | 10  | 8   | —   | —  | 74  | 174 | 176   | 194   | 287 | 281 | 101 | 83  |
| .5       | 40  | —   | —   | —  | 12  | 82  | 72    | 118   | 301 | 192 | 28  | 165 |
| 17.0     | 70  | —   | —   | —  | 8   | 16  | 10    | 68    | 186 | 103 | 4   | 132 |
| .5       | 128 | —   | —   | —  | 2   | 4   | 5     | 16    | 52  | 36  | 4   | 190 |
| 18.0     | 68  | —   | —   | —  | —   | 5   | —     | 5     | 20  | 11  | —   | 124 |
| .5       | 30  | —   | —   | —  | —   | 2   | 2     | —     | 6   | 3   | —   | 149 |
| 19.0     | 8   | —   | —   | —  | —   | —   | —     | —     | —   | —   | —   | 41  |
| .5       | 5   | —   | —   | —  | —   | —   | —     | —     | —   | —   | —   | 17  |
| 20.0     | 2   | —   | —   | —  | —   | —   | —     | —     | —   | —   | —   | —   |
| .5       | 2   | —   | —   | —  | —   | —   | —     | —     | —   | —   | —   | —   |
| N        | 600 | 128 | —   | —  | 923 | 922 | 1,256 | 1,284 | 715 | 640 | 248 | 121 |

Tableau 4 (suite)

## Lisbonne

1956

| L          | I   | II | III | IV  | V   | VI  | VII | VIII | IX  | X     | XI  | XII |
|------------|-----|----|-----|-----|-----|-----|-----|------|-----|-------|-----|-----|
| 8.0 .....  | —   | —  | —   | —   | —   | —   | —   | —    | —   | —     | —   | —   |
| .5 .....   | —   | —  | —   | —   | —   | —   | 8   | 4    | —   | 2     | 2   | —   |
| 9.0 .....  | —   | —  | —   | —   | —   | —   | 33  | 40   | 21  | 21    | —   | —   |
| .5 .....   | —   | —  | —   | —   | —   | 3   | 68  | 109  | 10  | 100   | 2   | —   |
| 10.0 ..... | —   | —  | —   | —   | —   | 13  | 99  | 121  | 62  | 199   | 33  | 20  |
| .5 .....   | —   | —  | —   | —   | —   | 95  | 156 | 183  | 162 | 203   | 113 | 30  |
| 11.0 ..... | —   | —  | —   | —   | —   | 150 | 220 | 155  | 233 | 148   | 192 | 94  |
| .5 .....   | —   | —  | —   | —   | —   | 77  | 220 | 155  | 172 | 111   | 166 | 178 |
| 12.0 ..... | —   | —  | —   | —   | —   | 19  | 115 | 93   | 170 | 73    | 158 | 221 |
| .5 .....   | —   | —  | —   | —   | —   | 8   | 45  | 54   | 102 | 60    | 123 | 201 |
| 13.0 ..... | —   | —  | —   | —   | —   | 3   | 14  | 53   | 49  | 22    | 128 | 124 |
| .5 .....   | 13  | —  | —   | 5   | —   | 3   | 1   | 19   | 22  | 6     | 43  | 58  |
| 14.0 ..... | 3   | —  | 14  | 5   | 12  | 50  | 1   | 8    | 9   | 3     | 31  | 7   |
| .5 .....   | 8   | —  | 21  | 36  | 65  | 114 | —   | —    | 6   | 4     | 2   | 18  |
| 15.0 ..... | 21  | —  | 42  | 32  | 135 | 217 | 6   | 2    | 2   | 6     | 2   | 10  |
| .5 .....   | 69  | —  | 130 | 95  | 247 | 149 | 7   | 1    | —   | 18    | —   | 8   |
| 16.0 ..... | 262 | —  | 270 | 168 | 191 | 64  | 4   | 3    | 1   | 9     | —   | 3   |
| .5 .....   | 264 | —  | 241 | 204 | 118 | 27  | 3   | —    | —   | 9     | 5   | —   |
| 17.0 ..... | 180 | —  | 115 | 172 | 86  | 5   | —   | —    | —   | 6     | —   | 13  |
| .5 .....   | 95  | —  | 87  | 164 | 86  | 3   | —   | —    | —   | —     | —   | 5   |
| 18.0 ..... | 50  | —  | 38  | 55  | 27  | —   | —   | —    | —   | —     | —   | 5   |
| .5 .....   | 13  | —  | 28  | 32  | 24  | —   | —   | —    | —   | —     | —   | 5   |
| 19.0 ..... | 11  | —  | 14  | 27  | 9   | —   | —   | —    | —   | —     | —   | —   |
| .5 .....   | 8   | —  | —   | 5   | —   | —   | —   | —    | —   | —     | —   | —   |
| 20.0 ..... | —   | —  | —   | —   | —   | —   | —   | —    | —   | —     | —   | —   |
| .5 .....   | —   | —  | —   | —   | —   | —   | —   | —    | —   | —     | —   | —   |
| N .....    | 378 | —  | 286 | 220 | 339 | 377 | 706 | 964  | 876 | 1,003 | 423 | 394 |

## Portimao

1955

| L          | I | II | III | IV    | V     | VI    | VII   | VIII  | IX    | X     | XI  | XII |
|------------|---|----|-----|-------|-------|-------|-------|-------|-------|-------|-----|-----|
| 8.0 .....  | — | —  | —   | —     | —     | —     | —     | —     | —     | —     | —   | —   |
| .5 .....   | — | —  | —   | —     | —     | —     | —     | —     | —     | —     | 1   | —   |
| 9.0 .....  | — | —  | —   | —     | —     | —     | —     | —     | 1     | —     | —   | 9   |
| .5 .....   | — | —  | —   | —     | —     | —     | —     | +     | 2     | —     | 1   | 33  |
| 10.0 ..... | — | —  | —   | —     | —     | —     | +     | +     | 2     | —     | 4   | 55  |
| .5 .....   | — | —  | —   | —     | —     | —     | 1     | 7     | 14    | 17    | 9   | 63  |
| 11.0 ..... | — | —  | —   | —     | —     | —     | +     | 25    | 56    | 61    | 24  | 84  |
| .5 .....   | — | —  | —   | +     | —     | —     | 1     | 31    | 118   | 132   | 58  | 100 |
| 12.0 ..... | — | —  | —   | 13    | —     | —     | 1     | 41    | 197   | 236   | 132 | 108 |
| .5 .....   | — | —  | —   | 88    | 14    | 4     | 1     | 44    | 164   | 293   | 199 | 117 |
| 13.0 ..... | — | —  | —   | 201   | 94    | 48    | 12    | 45    | 97    | 153   | 144 | 66  |
| .5 .....   | — | —  | —   | 281   | 331   | 176   | 88    | 61    | 52    | 62    | 66  | 44  |
| 14.0 ..... | — | —  | —   | 213   | 307   | 265   | 264   | 113   | 43    | 14    | 44  | 24  |
| .5 .....   | — | —  | —   | 115   | 166   | 255   | 255   | 187   | 49    | 11    | 26  | 44  |
| 15.0 ..... | — | —  | —   | 51    | 60    | 156   | 206   | 208   | 58    | 6     | 54  | 60  |
| .5 .....   | — | —  | —   | 21    | 17    | 61    | 113   | 141   | 60    | 6     | 70  | 76  |
| 16.0 ..... | — | —  | —   | 11    | 9     | 24    | 43    | 70    | 45    | 6     | 68  | 41  |
| .5 .....   | — | —  | —   | 4     | 1     | 8     | 12    | 19    | 26    | 3     | 46  | 39  |
| 17.0 ..... | — | —  | —   | 1     | +     | 2     | 3     | 5     | 11    | —     | 33  | 15  |
| .5 .....   | — | —  | —   | —     | 1     | —     | +     | 3     | 3     | —     | 18  | 9   |
| 18.0 ..... | — | —  | —   | —     | —     | 1     | —     | +     | 1     | —     | 1   | 3   |
| .5 .....   | — | —  | —   | —     | —     | +     | —     | —     | 1     | —     | 1   | 6   |
| 19.0 ..... | — | —  | —   | 1     | —     | —     | —     | —     | —     | —     | —   | 3   |
| .5 .....   | — | —  | —   | —     | —     | —     | —     | —     | —     | —     | 1   | —   |
| 20.0 ..... | — | —  | —   | —     | —     | —     | —     | —     | —     | —     | —   | —   |
| N .....    | — | —  | —   | 2,900 | 3,100 | 3,000 | 3,100 | 3,400 | 3,000 | 1,100 | 900 | 800 |

Tableau 4 (suite)

Portimao

| L          | 1956 |    |     |       |     |       |       |       |       |       |       |       |
|------------|------|----|-----|-------|-----|-------|-------|-------|-------|-------|-------|-------|
|            | I    | II | III | IV    | V   | VI    | VII   | VIII  | IX    | X     | XI    | XII   |
| 8.0 .....  | —    | —  | —   | —     | —   | —     | 6     | 2     | —     | —     | 23    | 9     |
| .5 .....   | —    | —  | —   | —     | —   | —     | 5     | 5     | —     | 1     | 83    | 33    |
| 9.0 .....  | —    | —  | —   | —     | —   | —     | 8     | 11    | 1     | 5     | 34    | 47    |
| .5 .....   | —    | —  | —   | —     | —   | —     | 8     | 29    | 8     | 8     | 41    | 76    |
| 10.0 ..... | —    | —  | —   | 3     | —   | 1     | 22    | 68    | 27    | 28    | 75    | 90    |
| .5 .....   | —    | —  | —   | 24    | 25  | 1     | 44    | 96    | 62    | 95    | 192   | 82    |
| 11.0 ..... | —    | —  | —   | 92    | 45  | 3     | 81    | 97    | 122   | 191   | 214   | 75    |
| .5 .....   | —    | —  | —   | 132   | 60  | 5     | 82    | 113   | 169   | 246   | 125   | 44    |
| 12.0 ..... | —    | —  | —   | 114   | 85  | 7     | 53    | 105   | 175   | 198   | 79    | 31    |
| .5 .....   | —    | —  | —   | 90    | 45  | 13    | 31    | 98    | 113   | 100   | 54    | 30    |
| 13.0 ..... | —    | —  | —   | 77    | 25  | 19    | 27    | 57    | 72    | 57    | 31    | 53    |
| .5 .....   | —    | —  | —   | 60    | 50  | 57    | 51    | 40    | 53    | 20    | 18    | 77    |
| 14.0 ..... | —    | —  | —   | 81    | 105 | 195   | 101   | 61    | 46    | 10    | 14    | 93    |
| .5 .....   | —    | —  | —   | 96    | 185 | 272   | 167   | 79    | 31    | 8     | 5     | 81    |
| 15.0 ..... | —    | —  | —   | 77    | 150 | 214   | 150   | 74    | 37    | 9     | 4     | 70    |
| .5 .....   | —    | —  | —   | 69    | 105 | 120   | 99    | 41    | 34    | 7     | 4     | 63    |
| 16.0 ..... | —    | —  | —   | 45    | 65  | 56    | 42    | 16    | 29    | 9     | 4     | 27    |
| .5 .....   | —    | —  | —   | 19    | 40  | 21    | 16    | 5     | 15    | 5     | —     | 10    |
| 17.0 ..... | —    | —  | —   | 11    | —   | 10    | 6     | 2     | 5     | 2     | —     | 3     |
| .5 .....   | —    | —  | —   | 4     | 5   | 3     | 1     | 1     | 1     | 1     | —     | 3     |
| 18.0 ..... | —    | —  | —   | 2     | —   | 2     | —     | —     | —     | —     | —     | 1     |
| .5 .....   | —    | —  | —   | 2     | 5   | 1     | —     | —     | —     | —     | —     | 1     |
| 19.0 ..... | —    | —  | —   | 2     | 5   | —     | —     | —     | —     | —     | —     | 1     |
| .5 .....   | —    | —  | —   | —     | —   | —     | —     | —     | —     | —     | —     | —     |
| 20.0 ..... | —    | —  | —   | —     | —   | —     | —     | —     | —     | —     | —     | —     |
| N .....    | —    | —  | —   | 1,696 | 200 | 2,300 | 4,086 | 2,900 | 2,696 | 2,499 | 1,795 | 2,302 |

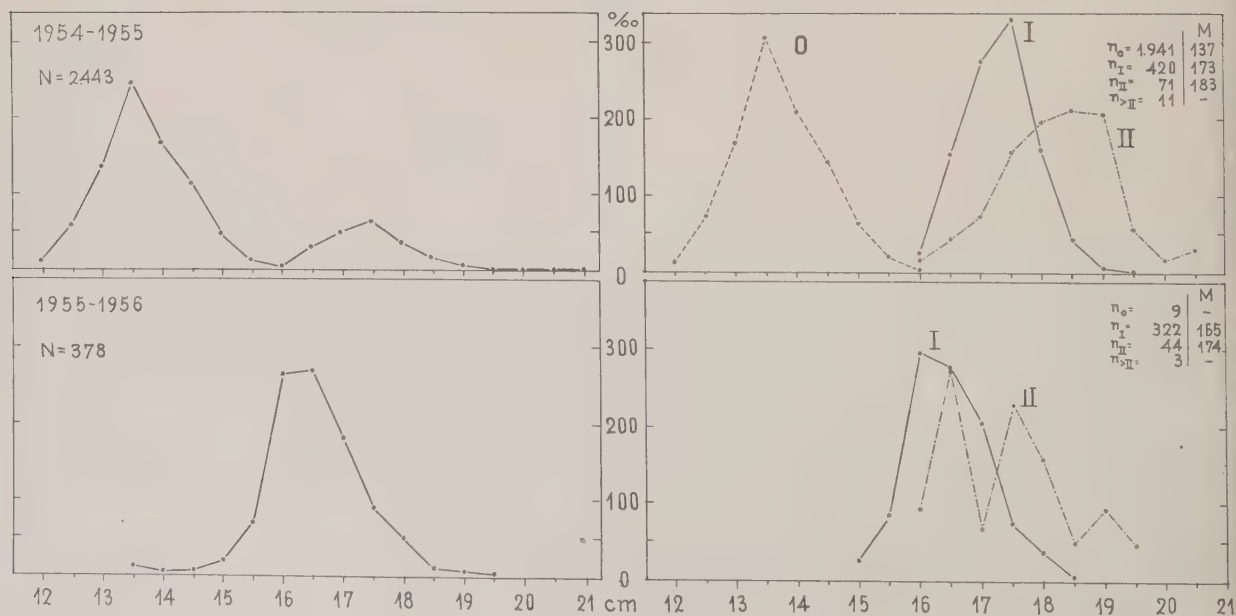


Figure 4. Tailles des classes 0, I et II, à Lisbonne. Observations pendant les hivers 1954—55 et 1955—56.



## Moyennes vertébrales par échantillons

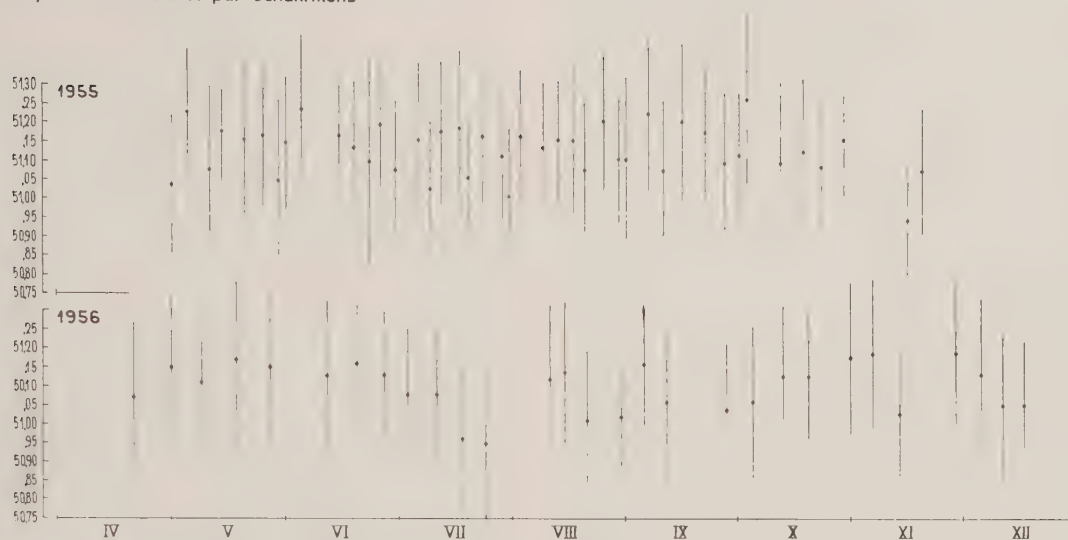


Figure 5. Moyennes vertébrales par échantillon.

millièmes des totaux de chaque hiver. On voit qu'en 1954—55 la classe 0 prédomine sur les classes I et II et qu'en 1955—56 c'est la classe I qui prédomine; il faut noter cependant que le nombre d'exemplaires observés ce dernier hiver (378) n'est pas suffisant pour donner une idée exacte de l'ensemble des sardines pêchées.

En ce qui concerne l'hiver de 1956—57 nous n'avons pas encore les résultats définitifs de la détermination de l'âge; nous pouvons dire, cependant, que la presque totalité des exemplaires étudiés appartenait à la classe 0 ce qui est d'accord avec les graphiques de la Figure 3. L'amplitude des tailles de la classe 0 varie entre 12.0 cm. et 16 cm.; il faut noter, cependant, que nous avons de très grands doutes au sujet de l'inclusion, dans cette classe, de sardines au dessus de 15 cm. Le problème est dans l'interprétation des petits anneaux, parfois très effacés, présentés par un nombre appréciable des écailles examinées; de sa valorisation dépend, dans une certaine mesure, les résultats obtenus.

L'amplitude de la classe I a varié entre 16.0 et 19.5 cm. en 1954—55 et entre 15.0 cm. et 18.5 cm. en 1955—56. Les mêmes doutes se posent ici sur la diagnose de l'âge des sardines plus grandes; un grand nombre d'écailles présentent des traces effacées d'un premier anneau d'hiver que nous n'avons pas considéré jusqu'à ce moment. Une révision du critère suivi s'impose.

À Portimao, d'une façon générale, la distribution des diverses classes d'âge ne présente pas les aspects observés à Leixoes et à Lisbonne; les sar-

dines des générations de 1955 et 1956 apparaissent, pour la première fois, dans le mois de Juillet, en très petit nombre et mélangées aux autres classes plus âgées. Dans les mois ultérieurs, en exceptant celui d'Août, on note, dans les deux années, une prédominance de la classe 0.

Le nombre d'écailles étudiées dans cette région n'est pas suffisant pour donner des informations rigoureuses sur l'amplitude de distribution des tailles par les diverses classes d'âge; toutefois nous pouvons dire, d'une façon générale, que les sardines de Portimao présentent une croissance différente de celles de Leixoes et de Lisbonne; sont très communes les écailles de poissons de 13.0 à 16.0 cm. présentant déjà deux anneaux d'hiver très nets. Il y a, peut-être, une croissance plus lente; il n'est pas possible, dans ce moment, d'en donner une autre interprétation.

**Moyennes vertébrales**

Les observations de sardines de Lisbonne ont été effectuées avec un total de 4,300 exemplaires en 1955 et de 2,900 en 1956. Les résultats enregistrés dans le graphique de la Figure 5 indiquent une variation des moyennes entre 50.90 et 51.27 en 1955, avec une moyenne annuelle de 51.13, respectivement 50.95 et 51.26, moyenne annuelle 51.12, en 1957.

**Maturité sexuelle**

Les observations entreprises à Lisbonne, suivant la routine des années précédentes, révèlent, dans les années de 1955 et de 1956, le même aspect

général. Les sardines aux gonades complètement mûres sont toujours très rares. Afin d'obtenir une classification des divers stades de maturation sexuelle traduisant, autant que possible, le stade physiologique des gonades, on a élaboré des nouvelles échelles de maturation, celle des ovaires, basées sur l'histologie de la gonade, et les mensurations des diamètres des oocytes (PINTO, J. S., et ANDREU, B. 1956. Proc. & Tech. Pap. C. G. P. M., 46), réalisées en collaboration avec le Laboratoire de Vigo, de l'Instituto de Investigaciones Pesqueras de l'Espagne. Celle des testicules est basée uniquement sur l'histologie et la délimitation des divers stades de maturation est faite conformément à l'évolution de la spermatogenèse. (PINTO, J. S., 1957. Not. e Estud. Inst. Biol. Mar., 15). L'échelle des ovaires donne des informations sur la diagnose des stades de post-ponte et de récupération en admettant la possibilité de plusieurs pontes à la même époque, séparées par des périodes de récupération. Ces faits n'étaient pas considérés dans la classification des sardines étudiées à Lisbonne jusqu'à présent. On a besoin d'adopter le nouveau critérium et d'essayer alors une interprétation générale des faits observés.

A. DE M. RAMALHO, J. SANTOS PINTO,  
et collaborateurs.

## Le Poids Moyen de la Sardine dans les Années 1952—1956

(Figure 6; Tableau 5)

Les données accumulées sur les poids de la sardine des environs de Lisbonne pendant les années 1952—1956 ont permis la détermination de la relation moyenne poids/taille. Les données sont enregistrées dans le Tableau 5. On a ajusté, par la méthode des moindres carrés, la courbe  $P=a+b L^3$ , où P désigne le poids et L la taille. Le résultat obtenu est  $P = -2.2 + 0.01182 L^3$ .

Dans le graphique de la Figure 6 est tracée la courbe obtenue, ainsi que les valeurs des poids moyens par classe de taille de 0.5 cm. et pour chacune des cinq années. En ce qui concerne les quatre premières années, la courbe obtenue s'ajuste bien aux poids moyens observés; en 1956, l'ajustement n'est pas si parfait pour les tailles audessus de 15 cm.

La courbe moyenne des cinq années ne diffère pas de la courbe ajustée de plus d'un gramme.

On avait essayé, antérieurement, la courbe  $P = b L^3$ , qui toutefois donnait un mauvais ajustement. On retournera sur ce problème, en essayant d'ajuster d'autres courbes, telles que la logarithique.

J. TIAGO DE OLIVEIRA et J. SANTOS PINTO

Tableau 5

L = Taille, cm.  
P = Poids total  
N = Nombre d'exemplaires  
pm = Poids moyen  
PM = Poids moyen de l'ensemble des cinq années

| L    | 1952   |      |      | 1953   |      |      | 1954   |      |      | 1955   |      |      | 1956   |     |      | PM   |
|------|--------|------|------|--------|------|------|--------|------|------|--------|------|------|--------|-----|------|------|
|      | P      | N    | pm   | P      | N    | pm   | P      | N    | pm   | P      | N    | pm   | P      | N   | pm   |      |
| 7.5  | 5      | 1    | —    | —      | —    | —    | —      | —    | —    | —      | —    | —    | —      | —   | —    | —    |
| 8.0  | 30     | 6    | 5.0  | —      | —    | —    | 47     | 9    | 5.2  | —      | —    | —    | —      | —   | —    | 5.1  |
| 8.5  | 221    | 38   | 5.8  | —      | —    | —    | 490    | 77   | 5.5  | —      | —    | —    | 70     | 13  | 5.4  | 5.6  |
| 9.0  | 144    | 21   | 6.9  | 7      | 1    | 7.0  | 1,259  | 170  | 7.6  | 37     | 4    | 9.3  | 572    | 83  | 6.9  | 7.5  |
| 9.5  | 219    | 26   | 8.6  | 110    | 11   | 8.6  | 2,245  | 254  | 8.6  | 195    | 23   | 8.5  | 2,138  | 264 | 8.1  | 8.5  |
| 10.0 | 1,025  | 103  | 10.0 | 370    | 32   | 10.2 | 5,846  | 555  | 10.3 | 615    | 63   | 9.9  | 4,382  | 468 | 9.4  | 10.0 |
| 10.5 | 3,121  | 257  | 11.6 | 1,479  | 101  | 11.3 | 8,163  | 666  | 11.6 | 1,172  | 105  | 11.7 | 7,941  | 729 | 10.9 | 11.4 |
| 11.0 | 6,232  | 463  | 13.5 | 3,898  | 259  | 12.2 | 10,774 | 757  | 13.7 | 1,678  | 125  | 13.3 | 10,840 | 831 | 13.0 | 13.1 |
| 11.5 | 7,369  | 469  | 15.1 | 7,778  | 479  | 14.4 | 14,824 | 893  | 15.7 | 4,197  | 268  | 15.5 | 11,108 | 735 | 15.1 | 15.2 |
| 12.0 | 6,788  | 374  | 16.4 | 10,331 | 570  | 16.6 | 20,954 | 1113 | 18.0 | 6,187  | 348  | 17.8 | 9,727  | 554 | 17.6 | 17.3 |
| 12.5 | 7,127  | 346  | 19.6 | 11,357 | 568  | 19.3 | 30,491 | 1446 | 20.5 | 4,195  | 232  | 20.1 | 7,302  | 367 | 19.9 | 19.9 |
| 13.0 | 7,363  | 319  | 21.8 | 10,047 | 446  | 22.0 | 32,608 | 1380 | 23.2 | 5,791  | 214  | 22.6 | 5,263  | 230 | 22.9 | 22.5 |
| 13.5 | 8,438  | 339  | 24.9 | 8,460  | 341  | 25.5 | 31,421 | 1180 | 26.3 | 7,750  | 270  | 25.9 | 2,384  | 92  | 25.9 | 25.7 |
| 14.0 | 14,366 | 514  | 28.2 | 9,903  | 356  | 28.4 | 20,495 | 694  | 29.8 | 5,178  | 176  | 29.3 | 1,893  | 65  | 29.1 | 29.0 |
| 14.5 | 31,338 | 991  | 31.7 | 13,549 | 426  | 32.1 | 15,011 | 451  | 32.9 | 13,786 | 420  | 32.8 | 3,216  | 99  | 32.5 | 32.4 |
| 15.0 | 33,647 | 955  | 36.2 | 22,945 | 640  | 36.3 | 16,480 | 361  | 36.4 | 27,615 | 475  | 37.7 | 6,306  | 174 | 36.2 | 36.6 |
| 15.5 | 43,671 | 1067 | 40.2 | 39,491 | 966  | 40.7 | 17,337 | 413  | 41.3 | 46,267 | 1084 | 42.2 | 9,881  | 251 | 39.4 | 40.8 |
| 16.0 | 50,814 | 1108 | 44.0 | 54,544 | 1183 | 45.1 | 25,423 | 555  | 46.1 | 54,312 | 1123 | 46.7 | 13,606 | 319 | 42.7 | 44.9 |
| 16.5 | 40,159 | 793  | 50.0 | 42,162 | 816  | 49.7 | 24,106 | 488  | 51.3 | 38,436 | 716  | 51.4 | 12,991 | 278 | 46.7 | 49.8 |
| 17.0 | 38,137 | 687  | 55.0 | 28,016 | 493  | 54.5 | 20,136 | 373  | 55.2 | 21,243 | 363  | 55.8 | 9,195  | 181 | 50.8 | 54.3 |
| 17.5 | 32,523 | 540  | 60.6 | 13,765 | 224  | 59.7 | 15,169 | 255  | 60.1 | 11,060 | 176  | 61.7 | 7,226  | 129 | 56.0 | 59.6 |
| 18.0 | 21,168 | 321  | 66.8 | 8,088  | 119  | 66.5 | 9,090  | 138  | 66.7 | 5,337  | 78   | 68.1 | 3,278  | 53  | 61.9 | 66.0 |
| 18.5 | 12,104 | 167  | 72.9 | 4,555  | 63   | 70.4 | 4,439  | 62   | 73.0 | 3,238  | 25   | 72.4 | 2,037  | 30  | 67.9 | 71.3 |
| 19.0 | 5,316  | 66   | 77.7 | 2,326  | 29   | 78.5 | 2,512  | 31   | 81.7 | 615    | 7    | 83.4 | 1,245  | 17  | 73.2 | 78.9 |
| 19.5 | 2,053  | 23   | 90.9 | 861    | 10   | 87.8 | 578    | 7    | 83.1 | 452    | 5    | 91.6 | 325    | 4   | 81.3 | 86.9 |
| 20.0 | 786    | 8    | 97.6 | 177    | 2    | 88.5 | 248    | 3    | 82.8 | 98     | 1    | 98.0 | —      | —   | —    | 91.7 |
| 20.5 | —      | —    | —    | —      | —    | —    | 90     | 1    | 90.0 | —      | —    | —    | —      | —   | —    | 90.0 |

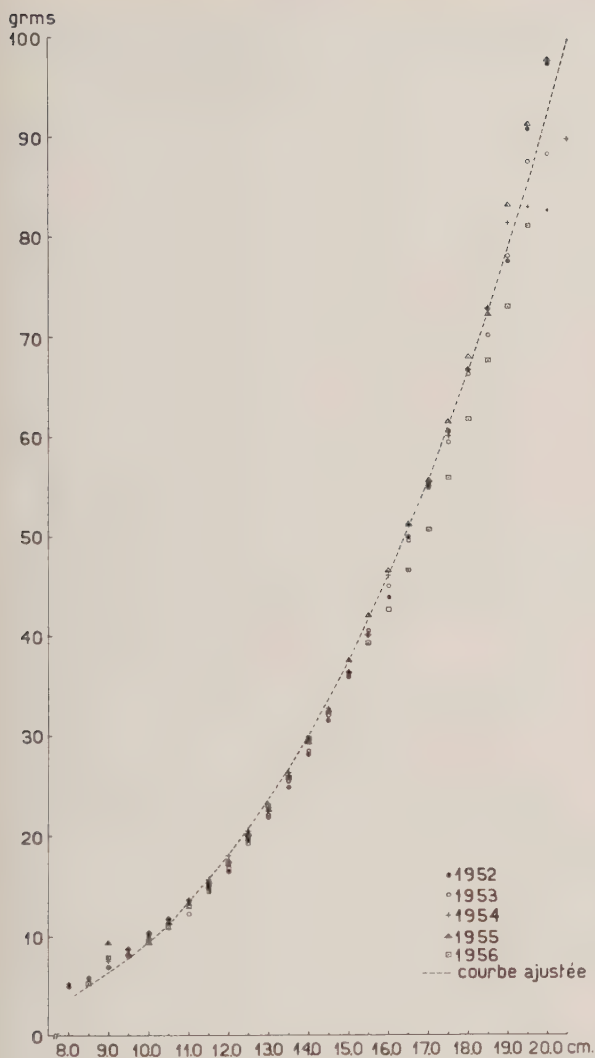


Figure 6. Courbe des poids moyens de la sardine des environs de Lisbonne. Années 1952—1955.

### Sprat

#### Danish Investigations in the Skagerak and Northern Kattegat

(Figure 7 and Table 6)

From the length distribution in spring (see Table 6 and Figure 7) it appears that the 1955 year-class dominated the catches off Frederikshavn in the first quarter of the year. In the fourth quarter of the year this class was predominant in the catches in almost all areas, but it is noteworthy that older sprat about 16½ cm. in length were also present in fairly large quantities, although in proportionately smaller numbers than in the same season in 1955. There is no doubt that in the Skagerak the 1955 year-class was comparatively rich.

In September 1955 large quantities of sprat larvae were taken in quantitative hauls by the "Dana" at the Tail End of the Dogger Bank, as well as at a station west of Thyborøn, and information from the fishermen indicated that larvae were numerous in the eastern North Sea between the Dogger Bank and the southern part of the Jutland coast.

Investigations show that the sprat caught in the Danish fishery had the same racial characteristics as usual (see Table 6). The V.S. values of the very few samples from the North Sea were relatively low, except in one sample from St. Andrew's Bay. We have therefore no right to assume that more

Figure 7. Average length distribution of sprat in depth zones above and below 40 m., respectively, in Danish catches from the south-eastern Skagerak and the northern Kattegat in each quarter (roman numerals) of the years 1952—56.

In the first quarter of 1954 catches only from the lowermost depth zone was investigated, in the first quarters of 1953 and 1956 some few catches from the second quarters are included and in those from the fourth quarter of 1955 some few from the end of September are included. Average growth of the sprat is shown by curves; the figures on these indicate year-classes.

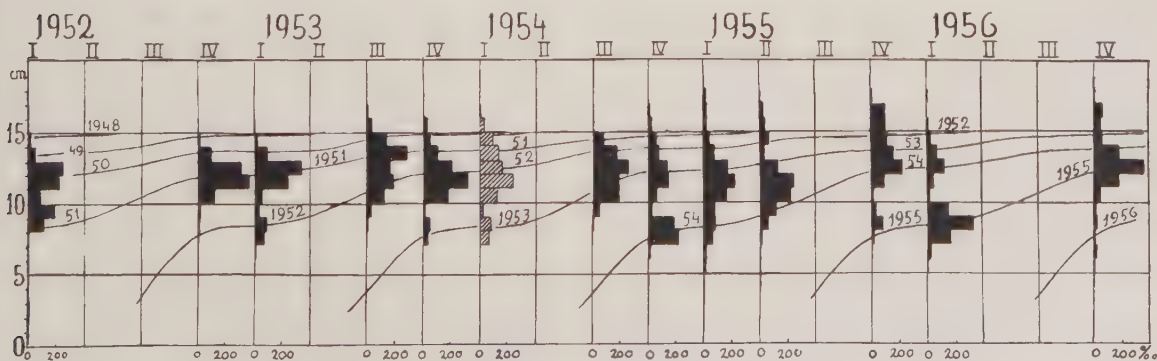


Figure 7.



Table 6. Mean values of the characteristics of sprat in the south-eastern Skagerak and northern Kattegat (the main area fished from Denmark) for each period in which observations were made and for autumn 1956. (Bracketed figures indicate numbers of fish)

|                      | V. S.       | K <sub>2</sub> |
|----------------------|-------------|----------------|
| 1939—40 .....        | 47.95 (199) | 11.73 (302)    |
| 1940—41 .....        | 47.93 (341) | 11.83 (270)    |
| 1941—42 .....        | 47.93 (90)  | 11.61 (90)     |
| 1942—43 .....        | 47.98 (125) | 11.73 (205)    |
| 1945—46 .....        | 47.92 (237) | 11.82 (107)    |
| 1946—47 .....        | 47.97 (321) | 11.61 (208)    |
| 1947—48 .....        | 47.93 (385) | 11.67 (255)    |
| 1948—49 .....        | 47.95 (109) | 11.88 (111)    |
| 1952—53 .....        | 47.92 (299) | 11.81 (329)    |
| 1953—54 .....        | 47.98 (126) | 12.02 (128)    |
| 1955—56 .....        | 47.93 (74)  | 11.86 (74)     |
| 1956 Sept.—Dec. .... | 47.97 (430) | 11.83 (268)    |

than an inconsiderable number of sprat taken in the Danish fishery in the Skagerak and northern Kattegat originated from the North Sea spawning grounds.

The means of V. S. for the stocks of sprat fished off the southern and western coasts of Norway which were computed by DANNEVIG ("Sprat from Norwegian Waters". Fiskeridirek. Skr., Ser. Havunders., 9 (2) 1951) varied between 47.43 and 48.32 (two samples gave 48.7), whereas the Danish values varied between 47.82 and 48.05, although the number of sprat examined in each sample was most often less than in the Norwegian samples. Consequently the wider spread of the Norwegian means is not due to the size of the samples, but indicates that the Norwegian stock contains fish which originate from spawning grounds other than those from which the stock in the south-eastern Skagerak and northern Kattegat are recruited. This applies to about 70% of the samples. The Danish and Norwegian samples with identical means may of course originate from the same spawning grounds; it is very likely that this holds in some cases, but not in all.

Thus the investigations clearly prove that only a minor part of the sprat stock on the Norwegian coast originates from the same spawning grounds as the stock in the south-eastern Skagerak and the northern Kattegat, and also that young fish from the south-eastern Skagerak do not form any considerable part of the stock on the Norwegian coast.

It has been assumed by BJERKAN and G. DANNEVIG that the stock of sprat in western Norway does not originate from local spawning, since quantitative hauls made over some few years have yielded only comparatively small numbers of larvae. Both authors have assumed that the stock of sprat in western Norway

was maintained mainly by influx from the Skagerak. Actually the range of the means of the numbers of vertebrae is about the same for the south and west coasts of Norway as for the Skagerak, but as mentioned above only a few of them are within the comparatively narrow range of the means found within the south-eastern Skagerak.

It is evident that if the population of sprat in western Norway is maintained by influx, the number found in western Norway must fluctuate very much from one year to another, as a result of not only large fluctuations in year-class strength but also of fluctuations in the strength of the current.

In recent years the output of the west Norwegian sprat fishery has been small, as it was in certain earlier periods, but latterly fears have arisen that the small yield was attributable to the Danish fishery for herring and sprat in the Skagerak. From what has been mentioned above, it is evident that the influence of the Danish sprat fishery on the yield on the Norwegian coast must be very small.

AA. J. C. JENSEN

### The Sprat in the Belts and Westernmost Baltic

(Table 7)

The characteristics of sprat of various length-groups caught in October-November in the Baltic and south of Als are as follows:—

| Length (mm.)     | V. S.       | K <sub>2</sub> |
|------------------|-------------|----------------|
| 50—80 .....      | 47.73 (317) | 11.58 (123)    |
| 80—90/100 .....  | 47.81 (273) | 11.82 (210)    |
| 90/100—130 ..... | 47.97 (60)  | 11.90 (62)     |

The figures in brackets indicate the number of fish examined.

For racial investigation, the sprats were divided into length-groups; in some cases they were divided at 90 mm. in others at 100 mm. In some samples they were also separated into age-groups, as determined from a preliminary inspection of the scales.

The scales and otoliths collected have not yet been re-examined but we may be sure that almost all sprat under 100 mm. in length were of the 0-group.

A distinct difference between the characteristics of the small and large sprat is evident. A similar difference has been found on the Norwegian coast and here also the largest fish had most vertebrae. It has been suggested by BJERKAN that the difference might be due to slight differences in age; the older sprat in a year-class might have been hatched at a lower temperature than the younger and conse-



**Table 7. Length distribution (‰) of sprat caught in the Belts and south of Als (westernmost Baltic) in 1956**

| Quarters of the year: | First | Second | Fourth |
|-----------------------|-------|--------|--------|
| Number of samples:    | 5     | 3      | 14     |
| cm.                   |       |        |        |
| 4 .....               | —     | —      | 9      |
| 5 .....               | —     | —      | 79     |
| 6 .....               | 14    | 6      | 193    |
| 7 .....               | 61    | 12     | 265    |
| 8 .....               | 204   | 36     | 202    |
| 9 .....               | 380   | 150    | 144    |
| 10 .....              | 102   | 234    | 27     |
| 11 .....              | 14    | 96     | 6      |
| 12 .....              | 111   | 87     | 29     |
| 13 .....              | 90    | 258    | 28     |
| 14 .....              | 23    | 118    | 16     |
| 15 .....              | —     | 4      | 2      |
| Total .....           | 999   | 1001   | 1000   |

quently have acquired more vertebrae. On the other hand MOLANDER assumed that the differences between the lengths of the sprat in a year-class is due to a difference in growth-rate and that the same external factors give rise to the fish's ability to grow faster and to acquire more vertebrae. DANNEVIG<sup>1)</sup> suggested that a correlation between ability to grow and number of vertebrae may be a hereditary character.

The occurrence of sprat in the southern Kattegat and the northern parts of the Belt Sea with exactly the same racial characters as the sprat in the south-eastern Skagerak and the northernmost part of the Kattegat suggests that a southward migration may take place through the Kattegat, and the difference between racial characteristics of the small and the large sprat in the Belt Sea might be the

result of an immigration to the Belt Sea from the south-eastern Skagerak and northern Kattegat.

At present the reason for the difference is quite unknown. Too low an estimate of  $K_2$  for the smaller fish may provide some of the difference in that character but this does not apply to V. S.

The length of the sprat in 1956 is shown in Table 7.

For the first and second quarters of the year only figures for catches in which no sprat had been sorted for human consumption were included in the table. For the fourth quarter of the year some of the larger sprat had been sorted from each of the samples analysed. It is evident nevertheless that a new rich year-class of sprat was present in the catches. The length distributions found in the first two quarters were about normal for the locality.

AA. J. C. JENSEN

### The Sprat in the Southern Baltic

(Figure 8, see next page)

The length and age composition of the southern Baltic sprat stock in 1956 is illustrated in Figure 8.

Large fish belonging mainly to the 1956 year-class predominated in winter and summer (before and during the spawning season). The proportion of large fish decreased markedly in the autumn months in all parts of the southern Baltic. Most of the fish then were of small size, belonging to the 1955 year-class. In contrast with former years, there were no fish of the 0-group (1956 year-class) seen in any of the samples examined in autumn 1956. This age-group appeared as only a very small part (0.2%) of the samples examined in the second half of January 1957.

J. ELWERTOWSKI

<sup>1)</sup> See G. DANNEVIG, Rep. Norw. Mar. Invest., 9 (12): 1—22, 1951.

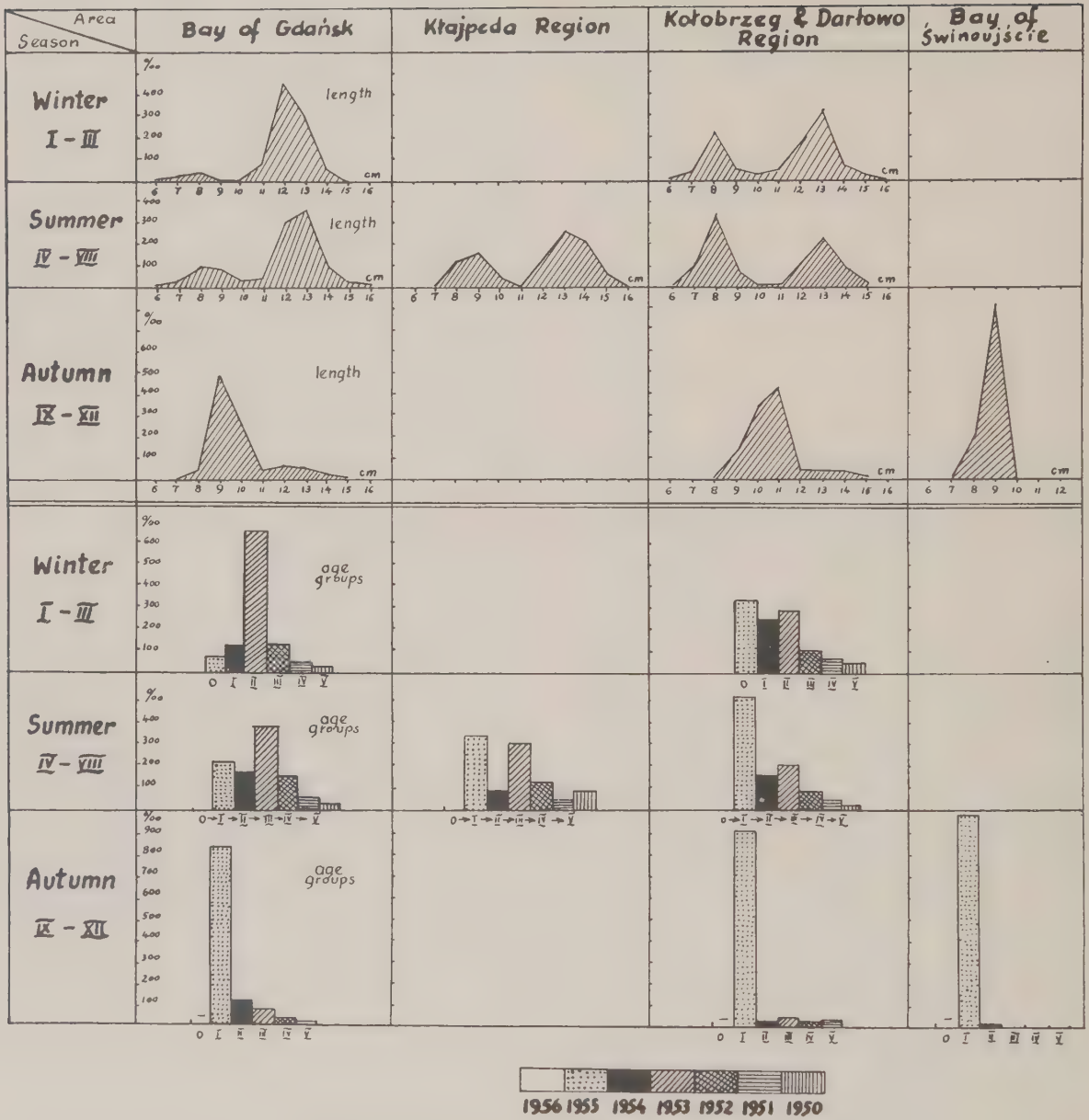


Figure 8. Length and age of sprat caught in the southern Baltic in 1956.

## Salmon and Trout

### England and Wales

#### Salmon and Sea Trout Experiments

#### River Coquet, Northumberland, and East Anglia

(Tables 1-3)

##### (a) River Coquet

Salmon and sea trout smolts were again tagged in the River Coquet at Warkworth between 17. March and 7. June. During the experiment 3,890 sea trout smolts and 3,587 salmon smolts were tagged with small Ivorine plates and also marked by the removal of the left pelvic fin, to obtain information on the rate of loss of these tags. In addition, 2,128 sea-trout kelts and 56 salmon kelts were examined for tags and released.

During the summer one of the sea trout smolts was caught about  $\frac{3}{4}$  mile upstream from the trap, one was recaptured in the sea just south of Amble, and one in Filey Bay, Yorkshire. This fish was caught only 14 days after being tagged.

Fish tagged in former years have also been recaptured during the 1956 season, and Tables 1 and 2 summarize these recaptures. None of the 1951-tagged fish has been reported and it is now unlikely that any more of that year's run will be seen again. A salmon, tagged as a smolt in April 1952, was caught as a kelt on the Warkworth trap on 21. April this year. The fish was 81.0 cm. long and the tag, which was partly buried in the dorsal body wall, had been on the fish for a little over four years, this represents the longest period for which any of our tags has been known to remain attached to a fish.

##### (b) East coast

In an endeavour to recover some of the fin-clipped sea trout smolts tagged in the River Coquet at Warkworth earlier in the year 121 young sea trout caught by commercial nets on the Norfolk coast were examined but this catch included neither tagged nor fin-clipped fish.

Table 1. Recaptures in 1956 of salmon tagged in previous years

| Year | Tagging data  |       | Recapture data for 1956              |        |        |       |                              |
|------|---------------|-------|--------------------------------------|--------|--------|-------|------------------------------|
|      | Number tagged |       | Number and stage at which recaptured |        |        |       | Place                        |
|      | Smolts        | Kelts | Smolts                               | Grilse | Salmon | Kelts |                              |
| 1952 | 2,157         | Nil   |                                      |        |        | 1     | Warkworth Trap               |
| 1953 | 3,497         |       |                                      |        | 2      |       | River Coquet, Rothbury       |
|      |               | 15    |                                      |        | 1      |       | Druridge Bay, Northumberland |
| 1954 | 2,859         |       |                                      |        |        | 1     | Warkworth Trap               |
|      |               | 37    |                                      |        | 27     |       | Northumberland coast         |
| 1955 | 4,000         |       |                                      | 8      |        |       | Northumberland coast         |
|      |               | 72    |                                      |        |        |       |                              |
| 1956 | 3,587         | Nil   |                                      |        |        |       |                              |

Table 2. Recaptures in 1956 of sea trout tagged in previous years

| Year | Tagging data  |       | Place:<br>Warkworth Trap | Recapture data for 1956              |           |       |                                        | Place |
|------|---------------|-------|--------------------------|--------------------------------------|-----------|-------|----------------------------------------|-------|
|      | Number tagged |       |                          | Number and stage at which recaptured |           |       |                                        |       |
|      | Smolts        | Kelts |                          | Smolts                               | Sea Trout | Kelts |                                        |       |
| 1951 | 3,930         | 48    |                          |                                      |           |       |                                        |       |
| 1952 | 7,503         | 659   |                          |                                      |           |       |                                        |       |
| 1953 | 5,671         | 872   |                          |                                      |           |       |                                        |       |
| 1954 | 5,022         | 1,021 |                          |                                      | 1         | 3     | Warkworth Trap<br>Northumberland coast |       |
|      |               |       |                          |                                      |           | 3     | R. Coquet, Felton to Morwick           |       |
| 1955 | 6,031         | 1,342 |                          |                                      | 1         |       | R. Coquet, Felton to Morwick           |       |
|      |               |       |                          |                                      | 2         |       | Northumberland coast                   |       |
|      |               |       |                          |                                      |           | 43    | Warkworth Trap                         |       |
|      |               |       |                          |                                      |           | 10    | R. Coquet, Felton to Morwick           |       |
|      |               |       |                          |                                      | 1         |       | R. Coquet, Rothbury                    |       |
|      |               |       |                          |                                      | 1         |       | R. Tweed, Low Bells                    |       |
|      |               |       |                          |                                      | 3         |       | Northumberland coast                   |       |
|      |               |       |                          |                                      | 1         |       | Filey Bay, Yorkshire                   |       |
|      |               |       |                          |                                      | 1         |       | Blakeney Point, Norfolk                |       |
| 1956 | 3,890         |       |                          | 1                                    |           |       | R. Coquet, Warkworth                   |       |
|      |               |       |                          | 1                                    |           |       | Northumberland coast                   |       |
|      |               |       |                          | 1                                    |           |       | Filey Bay, Yorkshire                   |       |
|      |               | Nil   |                          |                                      |           |       |                                        |       |

In 1955, over 700 sea trout were tagged off the East Anglian coast. During the present season a further 13 fish have been recaptured, the distribution of recaptures is shown in Table 3.

One fish was caught in the River Ouse at Barcome Mills, Sussex. This is the first occasion on which a fish tagged off the east coast has been recaptured west of the Straits of Dover. Altogether, 68 of the East Anglian fish have been recaptured, representing 8.7% of those tagged.

A. SWAIN, W. G. HARTLEY

Table 3. Recaptures in 1956 of sea trout tagged on the East Anglian coast in 1955

| Place Tagged    | Number tagged | Number recaptured | Place recaptured             |
|-----------------|---------------|-------------------|------------------------------|
| Hemsby .....    | 616           | 1                 | R. Tweed, Tillmouth          |
|                 |               | 1                 | R. Tweed, Berwick            |
|                 |               | 1                 | Great Yarmouth               |
|                 |               | 1                 | River Esk, Yorkshire         |
| Orford Ness ... | 147           | 1                 | R. Coquet, Rothbury          |
|                 |               | 1                 | R. Tweed, Norham             |
|                 |               | 1                 | R. Tweed, Bendibus           |
|                 |               | 1                 | Whitburn Bay, Co. Durham     |
|                 |               | 2                 | R. Tyne, off Estuary         |
|                 |               | 1 (kelt)          | R. Coquet, Warkworth Trap    |
|                 |               | 1                 | R. Ouse, Sussex              |
| Kessingland ... | 18            | 1                 | Druridge Bay, Northumberland |
| Southwold ....  | 7             | Nil               |                              |
| Totals .....    | 788           | 13                |                              |

### Salmon Stocks

During the year samples received from the Hampshire River Board late in 1955 have been examined. The results are as follows:—

| River  | No. | Smolt ages (%) |    |    |    | Sea age-group (%) |    |    |    |
|--------|-----|----------------|----|----|----|-------------------|----|----|----|
|        |     | 1              | 1+ | 2  | 2+ | 1+                | 2  | 2+ | 3  |
| Test   | 219 | 12             | 68 | 9  | 11 | 4                 | 42 | 24 | 26 |
| Itchen | 23  | 13             | 53 | 17 | 17 | 0                 | 48 | 30 | 13 |

The usual collection of scales from North Shields has been received from the Northumberland and Tyneside River Board. Records of smolt ages and adult age-groups over the past five years in this area are as follows:—

| Date | No. | Smolt ages (%) |    |   |   | Sea age-group (%) |    |    |   |    |    |
|------|-----|----------------|----|---|---|-------------------|----|----|---|----|----|
|      |     | 1              | 1+ | 2 | 3 | 1+                | 2  | 2+ | 3 | 3+ | SM |
| 1952 | 78  | 13             | 86 | 1 |   | 17                | 33 | 35 | 9 | 0  | 6  |
| 1953 | 82  | 2              | 89 | 9 |   | 10                | 29 | 37 | 7 | 0  | 17 |
| 1954 | 92  | 10             | 85 | 5 |   | 27                | 23 | 36 | 8 | 1  | 5  |
| 1955 | 29  | 10             | 90 | 0 |   | 36                | 3  | 55 | 3 | 3  | 0  |
| 1956 | 66  | 11             | 86 | 3 |   | 15                | 32 | 35 | 6 | 6  | 6  |

### Salmon and sea trout caught at sea

During the 1956 season, 51 sea trout were reported by Lowestoft trawlers, caught between 12. April and 6. October. As 43 others were reported in 1955, it seems probable that the capture of sea trout is less unusual than has been thought. The majority of these fish were caught about 45 miles N.E. by N. of Smith's Knoll, at about 17 fathoms depth.



A salmon was caught by a Grimsby trawler on 4. September about 70 miles east of the Humber. The fish weighed 14 lb., and had a scale reading of 2. 2+.

W. G. HARTLEY

#### Research on the physiology of salmon and sea trout

During the year, while occupying a Research Fellowship with the Ministry of Agriculture, Fisheries and Food, some work has been done on the ionic and osmotic changes which occur in the blood of salmon and sea trout during their migrations to and from the sea.

It has been found that when the young or adult fish are in fresh water, the level of salts is similar to that of other freshwater fish, and that when they are in sea water the salt concentration rises. A study of the blood of smolts during the seaward migration suggests that the change in composition occurs some time after the change in habitat and not before. A relatively greater degree of variability exists in the concentration of total salts and of individual ions during the passage from fresh to salt water.

GWYNETH HOWELLS

#### Anaemic disease in rainbow trout

A laboratory experiment has been in progress during the year on the so-called "anaemic disease" of rainbow trout.

Through the kindness of the Danish Trout Farmers Association rainbow trout ova were obtained from a farm at which the disease was known to occur. These, and some ova of British origin were hatched in the laboratory and the alevins divided into groups and given diets of fresh minced herring, fresh minced ox liver, and fresh minced herring + 10% ox liver.

The results of the experiments can be summarized thus:—

a. Typical symptoms of the anaemic disease (as seen on an inspection of the conditions at some Danish trout farms) were produced in both British and Danish rainbow trout alevins by feeding them on fresh minced herring (a high fat-content diet), and also on fresh minced herring with an addition of 10% of minced liver.

b. Both British and Danish alevins given a diet of fresh minced liver failed to develop symptoms of the disease.

c. When alevins receiving a liver diet were kept in aquaria supplied with water from other aquaria in which affected fish, receiving a herring diet, were kept, the mortalities in the liver diet aquarium did not exceed those of a control experiment in which liver-fed fish were kept in water supplied direct from the mains.

There was, therefore, no evidence of cross-infection through the water supply between the affected and non-affected fish.

d. When alevins of both nationalities were changed over on to a herring diet after some weeks on a liver diet no deaths occurred for some months although some typical symptoms, such as exophthalmia and extension of the abdomen occurred. After some time, however, discolouration, loss of balance and erratic swimming developed and mortalities started to occur amongst fish of both nationalities.

e. Attempts to infect normal fish receiving a liver diet by feeding them, on isolated occasions, with freshly killed affected fish have proved unsuccessful.

I. R. H. ALLAN

#### Germany

The yield of the German salmon fishery in the south-eastern part of the Baltic has considerably increased, from 157 tons in 1955 to 286 tons in 1956. Within three years, the annual yield has tripled, and reached a greater amount than ever. Except for the second half of January and February, with severe cold and ice, catches in the first half of the year were good. In the autumn, the drift-line fishery commenced at the beginning of October, and resulted in very good catches, probably due to favourable weather conditions and unusually low water temperature in the last months of the year. The season 1956/57 therefore promises a record yield. The average landing per trip which had dropped from 594 kg. in 1954/55 to 493 kg. in 1955/56, rose to 975 kg. in 1956/57.

The size composition of the landings at the Kiel fish market in 1956 is given below:—

| Market category       | V          | IV   | III   | II    | I   |
|-----------------------|------------|------|-------|-------|-----|
| Gutted weight, kg.    | <2         | 2—3  | 3—4.5 | 4.5—8 | >8  |
|                       | Number (%) |      |       |       |     |
| January—February .    | 2          | 13   | 16    | 47    | 22  |
| March—April . . . . . | 2          | 21   | 26    | 35    | 16  |
| May—June . . . . .    | 1          | 17   | 35    | 35    | 12  |
| October . . . . .     | 3          | 27   | 29    | 37    | 4   |
| November . . . . .    | 1          | 20   | 37    | 38    | 4   |
| December . . . . .    | 0          | 30   | 36    | 30    | 4   |
| Total catch . . . . . | 1.0        | 23.7 | 32.4  | 34.7  | 8.0 |

A remarkable change in the size composition of the landings has taken place in the course of the year, especially as regards the largest salmon (I). Their proportion decreased steadily from 22% in the beginning of the year to 12% in the spring. After the summer months when the German salmon fishery is suspended, the largest market category amounted only to 4%, whereas the next category II

was the same as before. The percentage of smaller salmon rose — category III from 16 to 37% and category IV from 13 to 30%. The quantity of smallest fish (IV) in the landings is as negligible now as previously. As the yield in the last months of the year has increased over that of the same period of the previous year, it is obvious that in reality the number of large salmon caught by German fishermen has increased, as will be seen from the following figures: —

**Number of salmon landed at Kiel fish market in 1955 and 1956**

| Market category | I     | II     | III    | IV     | V     | Unsorted |
|-----------------|-------|--------|--------|--------|-------|----------|
| 1955 ....       | 2,450 | 10,241 | 4,074  | 5,329  | 1,768 | 68       |
| 1956 ....       | 3,418 | 14,862 | 13,911 | 10,141 | 422   | 144      |

The numbers of fish of medium size (market category II—IV) has greatly increased, obviously owing to a rich year-class passing its second winter in the sea. The appearance of this abundant year-class (1952?) in the south-eastern Baltic in the season 1956/57 has caused an unexpected rise in the landings, probably not only for the German salmon fishery.

R. KÄNDLER

### Scotland

#### Tagged Kelt recaptured off Greenland

This fish was one of a number impounded at Loch-na-Croic, Ross-shire during the autumn of 1955 to provide eggs for the hatchery operated by the North of Scotland Hydro-Electric Board at Contin. After stripping, it was tagged and released on 23. November 1955. It was recaptured in Eqalug Fjord, south of Sukkertoppen, W. Greenland (64°56½' N., 52°02' W.) on 15. October 1956.

K. A. PYEFINCH

### Spain

During the 1956 season the catch of salmon was as follows: —

| Rivers           | Number caught |       |
|------------------|---------------|-------|
|                  | 1955          | 1956  |
| Ason .....       | 702           | 1,051 |
| Pas .....        | 39            | 121   |
| Nansa .....      | 89            | 57    |
| Deva-Cares ..... | 1,437         | 1,993 |
| Sella .....      | 1,068         | 1,236 |
| Navia .....      | 725           | 1,169 |
| Narcea .....     | 623           | 1,108 |

In 1956 43.2% more salmon were taken than in 1955, the increase being well distributed amongst all the rivers of the region. The mean weight of the fish was well maintained in the River Ason (5.1 kg.),

it increased slightly in the River Pas (5.6 kg.), and decreased in the Rivers Nansa (4.9 kg.) and Deva (4.4 kg.).

In the rivers of the Province of Asturias, restocking was carried out by means of fry distributed as follows: —

| Rivers       | Number  |
|--------------|---------|
| Sella .....  | 101,000 |
| Cares .....  | 101,000 |
| Narcea ..... | 101,000 |
| Navia .....  | 40,000  |
| Canero ..... | 15,000  |

In the Province of Santander restocking was carried out with Vibert boxes, containing 800 eyed ova of salmon.

| Rivers        | Number of eggs | Mortality |
|---------------|----------------|-----------|
| Nansa .....   | 20,800         | 2.16%     |
| Deva .....    | 20,000         | ?         |
| Pas .....     | 43,200         | 1.46%     |
| Pisuena ..... | 32,000         | 1.68%     |
| Miera .....   | 19,200         | 2.72%     |

“Smolts” with a mean weight of 35 g. and a mean length of 14.8 cm. were recaptured in the River Miera. This river was restocked with salmon in 1955 for the first time for thirty years, salmon having disappeared from that river thirty years ago.

In the upper parts of the River Pas “smolts” with a mean weight of 25.6 g. and a mean length of 14.5 cm. were obtained from the hatching of ova in 1955 by means of Vibert boxes.

J. CUESTA

### Sweden

Table 4. Salmon catches in tons in Sweden

| Year      | Total Sea | Baltic | Gulf of Bothnia | Baltic rivers |
|-----------|-----------|--------|-----------------|---------------|
| 1951 .... | 1,080     | 749    | 331             | 210           |
| 1952 .... | 790       | 460    | 330             | 226           |
| 1953 .... | 422       | 273    | 149             | 174           |
| 1954 .... | 484       | 364    | 120             | 130           |
| 1955 .... | 296       | 179    | 117             | 110           |

Table 5. Baltic catch of salmon

| Year      | Finland | Denmark | W. Germany | Poland |
|-----------|---------|---------|------------|--------|
| 1951 .... | 352     | 1,096   | 136        | 128    |
| 1952 .... | 383     | 1,350   | 144        | 67     |
| 1953 .... | 350     | 753     | 75         | 71     |
| 1954 .... | —       | 962     | 121        | 144    |
| 1955 .... | —       | 609     | 157        | 41     |

Table 6. Catch in numbers per unit of effort for Swedish fishermen

| Year          | Gothland (1,000 hooks) | Blekinge (100 nets) |
|---------------|------------------------|---------------------|
| 1951 ....     | 29.9                   | 8.0                 |
| 1952 ....     | 29.0                   | 7.7                 |
| 1953 ....     | 27.2                   | 4.4                 |
| 1954 ....     | 41.6                   | 4.5                 |
| 1955 ....     | 37.9                   | 6.6                 |
| 1956 (Spring) | —                      | 12.9                |

Table 7. Size of salmon taken by Swedish fishermen

| (a) In the Gothland fishery |                                     |                                           |    |     |    | (b) In the Blekinge spring fisheries (net fishing only) |                                     |                              |    |     |
|-----------------------------|-------------------------------------|-------------------------------------------|----|-----|----|---------------------------------------------------------|-------------------------------------|------------------------------|----|-----|
| Year                        | Total<br>number of<br>salmon caught | Percentage<br>of size group <sup>1)</sup> |    |     |    | Year                                                    | Total<br>number of<br>salmon caught | Percentage<br>of size groups |    |     |
|                             |                                     | I                                         | II | III | IV |                                                         |                                     | I                            | II | III |
| 1951 .....                  | 32,045                              | 23                                        | 27 | 32  | 18 | 1952 .....                                              | 2,530                               | 37                           | 39 | 24  |
| 1952 .....                  | 22,791                              | 26                                        | 22 | 31  | 21 | 1953 .....                                              | 1,557                               | 42                           | 37 | 21  |
| 1953 .....                  | 14,494                              | 18                                        | 19 | 25  | 38 | 1954 .....                                              | 1,283                               | 25                           | 44 | 32  |
| 1954 .....                  | 29,511                              | 8                                         | 13 | 31  | 48 | 1955 .....                                              | 1,994                               | 24                           | 38 | 38  |
| 1955 .....                  | 9,434                               | 16                                        | 21 | 34  | 29 | 1956 .....                                              | 6,721                               | 25                           | 24 | 51  |
| 1955 Jan.—June              | 6,371                               | 11                                        | 12 | 38  | 39 |                                                         |                                     |                              |    |     |
| 1955 Aug.—Dec.              | 3,063                               | 23                                        | 40 | 28  | 9  |                                                         |                                     |                              |    |     |
| 1956 Jan.—June              | 7,380                               | 31                                        | 20 | 46  | 3  |                                                         |                                     |                              |    |     |

<sup>1)</sup> I = Fish weighing 8 kg. or upwards; II, fish 6—8 kg.; III, fish 3—6 kg., and IV, fish up to 3 kg.

G. ALM

## Shellfish

### CRUSTACEA

#### Lobster Production in Norway

In the season 1956, the lobster rearing at Flødevigen was successful; about 40,000 small lobsters were liberated.

On the coast between Kragerø and Lista we many years have collected precise information as to the catches of in all 25 to 30 fishermen. The table gives the numbers of lobsters above 21 centimetre taken per gear used.

The number of gear per fisherman is higher in the western than in the eastern part. The number caught in 1956 does not vary considerably from the earlier years.

| Average      | Jomfruland-<br>Risør | Arendal-<br>Ulvøysund | Skogsøy-<br>Lista |
|--------------|----------------------|-----------------------|-------------------|
| 1928—39 . .  | 10.0                 | 5.8                   | 3.2               |
| 1940—49 . .  | 14.6                 | 6.5                   | 4.3               |
| 1950 . . . . | 13.8                 | 6.9                   | 4.1               |
| 1951 . . . . | 14.0                 | 7.6                   | 4.4               |
| 1952 . . . . | 8.7                  | 6.2                   | 4.6               |
| 1953 . . . . | 9.1                  | 6.9                   | 3.5               |
| 1954 . . . . | 11.3                 | 7.2                   | 2.6               |
| 1955 . . . . | 9.8                  | 5.3                   | 3.0               |
| 1956 . . . . | 9.8                  | 6.4                   | 5.3               |

A. DANNEVIG

### MOLLUSCA

#### Oyster

#### Larvae and Spatfall of Oysters in the Oosterschelde (Netherlands) in 1956

(Figure 1)

To assist the oystermen in their efforts to produce a good crop of spat, we continued our observations on the number and size of oyster larvae in the water of the Oosterschelde in the year 1956. The methods used in collecting samples of 100 litres of water and in counting and measuring the larvae in such samples have been described previously. The samples were again collected at the Yersche Bank station in the centre of the Oosterschelde. Daily samples were taken at high slack water from 13. June up to 23. June inclusive; twice-daily samples at high slack and low slack water in the height of the season from 25. June up to 10. August inclusive. From 11. August up to 4. September daily samples were collected at high slack water. It was impossible to collect plankton samples on Sundays when our boats stayed in port. When two samples were taken in a day, the average number of each size-class has been computed for 100 litres, and is depicted in the diagram (Figure 1). The intensity of setting was measured in the usual way by exposing 3 lime-coated glass slides, measuring

13x18 cm., at an angle of 45° in a concrete container for periods of 3 days. The average number of spat per slide is shown in the diagram. The average number of the barnacle *Elminius modestus* DARWIN on 10 cm.<sup>2</sup> of the slides (5 cm.<sup>2</sup> upper plus 5 cm.<sup>2</sup> lower surface) has also been depicted in the diagram.

In the general outlook, based on the great number of mother oysters and their excellent condition, an ample production of larvae was predicted, which could only lead to a disappointing setting of spat if water temperatures stayed for prolonged spells under 18°C. According to the lunar periodicity pattern a great peak in the production of larvae was to be expected at about 5. July. The second part of winter had been unusually severe, and throughout the month of February huge ice fields had covered the Oosterschelde. After the thaw the oysters appeared to have suffered very little. Even the 1955 spat appeared to be in good condition on both tiles and mussel shells. Water temperature in March was 1.6°C. under the normal level; in April 1.2°C. lower than usual; but May was only 0.3°C. too cold. The first half of June was very cold again, viz., 13.8°C. on average, whereas 16.5°C. would have been the normal figure. The second half of June was only slightly better with 15.0° and 17.3°C. as the normal level. It was not



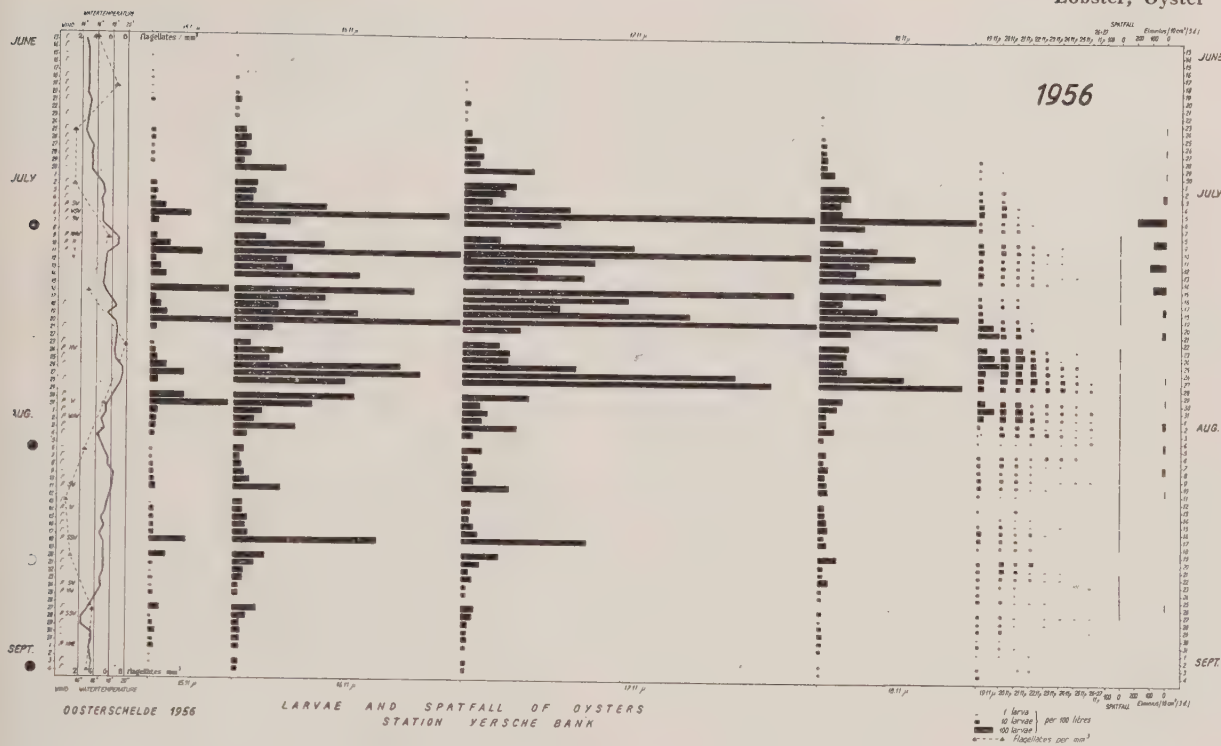


Figure 1.

surprising, therefore, that very few larvae were seen before 20. June. Though water temperature did not surpass the 16°C. level until the first days of July, it could be stated in the bulletin issued 4. July that some 500 oyster larvae could already be counted per 100 litres of water. A further increase should, however, be expected. Though rough weather and low water temperatures prevailed early in July, huge numbers of oyster larvae made their appearance, especially on 6. July. The bulletin dated 9. July indicated, however, that larval development remained very poor as water temperatures were too low, so that no setting could as yet be anticipated. A slight improvement in environmental conditions was reported in the bulletin of 12. July, but as the temperature had dropped again meanwhile, larval development was still so poor that "mature" larvae, ready to settle, were still virtually absent, though the total number of larvae remained high. On 17. July conditions were reported as stationary, and even as late as 20. July, with water temperatures at the 18°C. level, larval growth was still rather poor, so that no setting at a commercial level could yet be announced. On 23. July the arrival of enormous numbers of young larvae was reported, together

with a slightly better growth; but the number of "mature" larvae was still too low to predict a fair setting. It was not before 25. July that better larval development at higher water temperatures and coinciding with a good supply of flagellates could be reported. A setting of some importance was announced. In the bulletin issued on 28. July it was said that larval development was again much better, so that good setting conditions could be expected before long. On 3. August interference of cold and stormy weather had to be reported, which slowed down larval development though there were still enough "mature" larvae to expect some setting in the first few days to come. In the bulletin issued on 9. August it was said that both umbo and "mature" larvae had become rather rare so that setting conditions had dropped well under the commercial level.

The diagram demonstrated that the total production of larvae has been very great, indeed, in the year 1956, exceeding even that of the previous years and commensurate with a further increase in the stock of oysters. Apparently the cold winter and the low temperatures in spring and early summer hardly influenced the number of eggs produced per individual oyster. As usual,

July was the big month for larval production and no retardation due to low temperatures in the preceding weeks could be observed. A great peak in larval production made its appearance on 6. July, only one day later than anticipated. Very great numbers of larvae were again seen on 10. July, 16. July, 19.—20. July, and 27.—28. July. As was the case in 1955, the larvae were of quite a large size when they made their appearance in the plankton. In August the production of larvae was quite modest, with a peak on 18. August, some 12 days after the new moon. The diagram demonstrates that larval development was unprecedentedly poor until late in July, reasonably good at the end of that month, but declining again after the first days of August. It is noteworthy that the period of good larval development coincided not only with higher water temperatures, but also with a peak in the population of small flagellates.

Setting on the lime-coated glass collectors was completely absent up to 6. July, and very poor in the remainder of the season, with a slight increase only in the period 7.—10. August. This does not tally with the great number of "mature" larvae, ready for settling, observed in the period 25. July to 8. August.

Commercially the spatfall season 1956 was not as bad as the diagram seems to indicate. The oystermen kept the tile collectors ashore till after the middle of July, and feared a complete failure. When our bulletins announced fair setting conditions late in July, the oystermen did their utmost to bring out as many tiles as possible, though unprecedentedly late in the season. Unlike our test slides, the tiles caught a good set of spat late in July and in the first few days of August. Some 150 to 300 young oysters could be counted on many of the tiles later in the year. The spat was, however, of a much smaller size at the approach of winter, than in other years. The oystermen feared that this would entail a greater vulnerability to winter conditions, but at the end of the mild winter 1956—1957 survival appeared to be very good, indeed. Due to the late season and the short duration of good setting conditions, only some 1,400,000 tiles have been planted in the year 1956. Mussel shells scattered as collectors (9,400 m.<sup>2</sup>) could not be kept ashore until setting conditions improved. Therefore setting was on an average rather poor on the mussel shells, viz., under 10 per 100 shells, and only on exceptionally good plots on the deeper slope of the Yersche Bank and in the eastern part of the Basin of the Oosterschelde were we able to count from 50 to 100 young oysters per 100 mussel shells in the month of September.

The setting of the barnacle *Elminius modestus* showed a peak in the first half of July, but as the diagram demonstrates, all tiles placed at a later date caught so few barnacles, that the young oysters did not suffer appreciably from this competitor.

P. KORRINGA

## The Quality of Marketable Oysters from the Zealand Waters in 1956

(Figures 2-3; Table 1)

The observations on the quality of marketable oysters developed in the various districts of the Zealand waters have been continued in the year 1956. Again this quality has been expressed as a condition index measured at the end of the fattening season, in November and December 1956. Various hydrographical and biological factors, presumably associated with the growth and fattening of oysters, have been observed on a weekly basis throughout the year.

From 5 plots in the Basin of the Oosterschelde (i.e., Yersche Bank Nos. 183, 220, 337, 371, and eastern section No. 417) we have taken a series of samples on a fortnightly basis from the middle of May till late in the year. The tendency of the condition indices was remarkably similar on these 5 plots, and the graph (Figure 2) depicting the average condition index is therefore considered characteristic of the entire oyster population in the Basin of the Oosterschelde, though minor fluctuations will certainly have occurred.

The oysters hibernated in excellent condition (condition indices ranged well over 100), and the very low temperatures prevailing in the month of February 1956 (Table 1) did not lower their condition appreciably, nor did they seriously affect

Table 1. Water temperature in the Oosterschelde 1956 (°C.)

| Month               | 1956 | 1955 | Average<br>1921—1939 |
|---------------------|------|------|----------------------|
| January . . . . .   | 3.7  | 1.7  | 3.0                  |
| February . . . . .  | —1.2 | 2.4  | 2.9                  |
| March . . . . .     | 3.3  | 2.3  | 4.9                  |
| April . . . . .     | 7.2  | 8.3  | 8.5                  |
| May . . . . .       | 13.1 | 11.8 | 13.3                 |
| June . . . . .      | 14.4 | 15.7 | 16.9                 |
| July . . . . .      | 17.7 | 19.1 | 19.0                 |
| August . . . . .    | 16.8 | 19.7 | 18.8                 |
| September . . . . . | 15.9 | 17.9 | 16.6                 |
| October . . . . .   | 13.0 | 12.9 | 12.1                 |
| November . . . . .  | 7.2  | 8.2  | 7.1                  |
| December . . . . .  | 6.2  | 5.8  | 3.6                  |

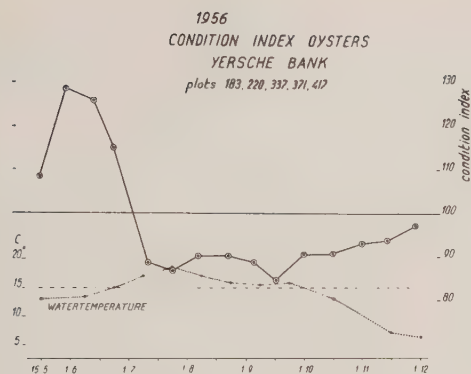


Figure 2.

the time the oysters could stand air exposure. Late in May we observed a rapid increase in condition, indicating active feeding of the oysters at a water temperature of some  $13^{\circ}\text{C}$ . The maximum figures approached a condition index of 130, and were attained late in May. This value corresponds closely to that attained in 1955 (Ann. Biol., XII, p. 255, Fig. 3), but the highest peak came somewhat earlier in the year 1956, which I ascribe tentatively to the higher water temperatures in May 1956. A very steep drop in condition occurred this year, again between 15. June and 15. July, due to active spawning of the entire oyster population. Again, the lowest values of the indices recorded dropped under 90. Contrasting sharply with the events in 1955, the oysters did not show a fast recovery in August and September of 1956. After a slow rise to hardly above the 90 level, the condition index dropped again in the middle of September. The water in the Oosterschelde being poorer in phytoplankton in this month than in August, lack of food may have been the reason for the September decline. In October and November the condition of the oysters increased but slowly, and the level attained late in the year was under 100 practically everywhere in the Oosterschelde, which indicates that the oysters were of mediocre condition, whereas they were exceptionally good 1955. The oysters were, however, healthy; "hockley" oysters and "gapers" being rare, and the mortality rate exceptionally low.

Condition indices, measured in November and December 1956, have been charted (Figure 3). Comparison with the year 1955 (Ann. Biol., XII, p. 226, Fig. 4) demonstrates clearly that the oysters in the Basin of the Oosterschelde were of a much poorer quality in 1956, indices over 100 being rare. It is amazing, that the few plots where oysters of really good quality were found (i.e., 183, 249, 317, 320, 322, 464, 479, 502, 533) are not reckoned to be

good fattening grounds, whereas the excellent plots in the central area of the Yersche Bank yielded disappointing results in 1956. Commensurate with the rather disappointing quality of the oysters, their growth was also decidedly poorer than in an average year, and lagged far behind the exceptionally good growth observed in the year 1955.

It is a striking fact that the oysters in the Zandkreek district (in between the islands of North and South Beveland) were in very good condition again in 1956. In fact they fell only little behind the perfect oysters gathered here in 1955. It goes without saying that this pleasant surprise was a great advantage for those among the oystermen who had planted reasonable quantities of oysters in this area, notwithstanding the greater losses to be expected here. Further, the Vlij of Ouwerkerk (S. E. of the town of Zierikzee) and the Grevelingen area in the North gave good results, the condition of the oysters not lagging behind those observed in 1955. Evidently, the distinction between a good and a mediocre year does not hold good for the entire area. Weather conditions being virtually the same in the various parts of the oyster district, local biological conditions, including the number of oysters per volume of water, must have shown a different pattern in 1956, as compared with 1955. This demonstrates that it is not sufficient to analyse water samples from one centrally placed station only, if one wants to achieve a good insight into the factors governing fattening.

Still, it is interesting to record here the general trend of the hydrographical and biological conditions, derived from analysis of water samples taken on a weekly basis in the centre of the oyster district, in the Basin of the Oosterschelde. As appears from Table 1, *water temperatures* were over  $1^{\circ}\text{C}$ . higher in May 1956 as compared with 1955, which may account for the rapid increase in condition in the month of May. The summer of 1956 was very much colder than that of 1955, and also than the average for the period 1921—1939. June was over  $1^{\circ}\text{C}$ . colder than in 1955, July over  $1\frac{1}{2}^{\circ}$ , August some  $3^{\circ}\text{C}$ ., and September  $2^{\circ}$  colder than in the previous year. October, November, and December showed normal water temperatures. The very cold summer may at least partly account for the rather poor growth of the oysters, but considering the very steep rise in condition, indicating vigorous feeding, in the month of May at water temperatures of about  $13^{\circ}\text{C}$ ., low water temperatures can hardly be the reason for the poor fattening in August and September. *Salinity* was rather high in the first three months of 1956 (i.e.,  $28.0_{/00}$ ), decidedly lower in March after the thaw ( $26.5_{/00}$ ),



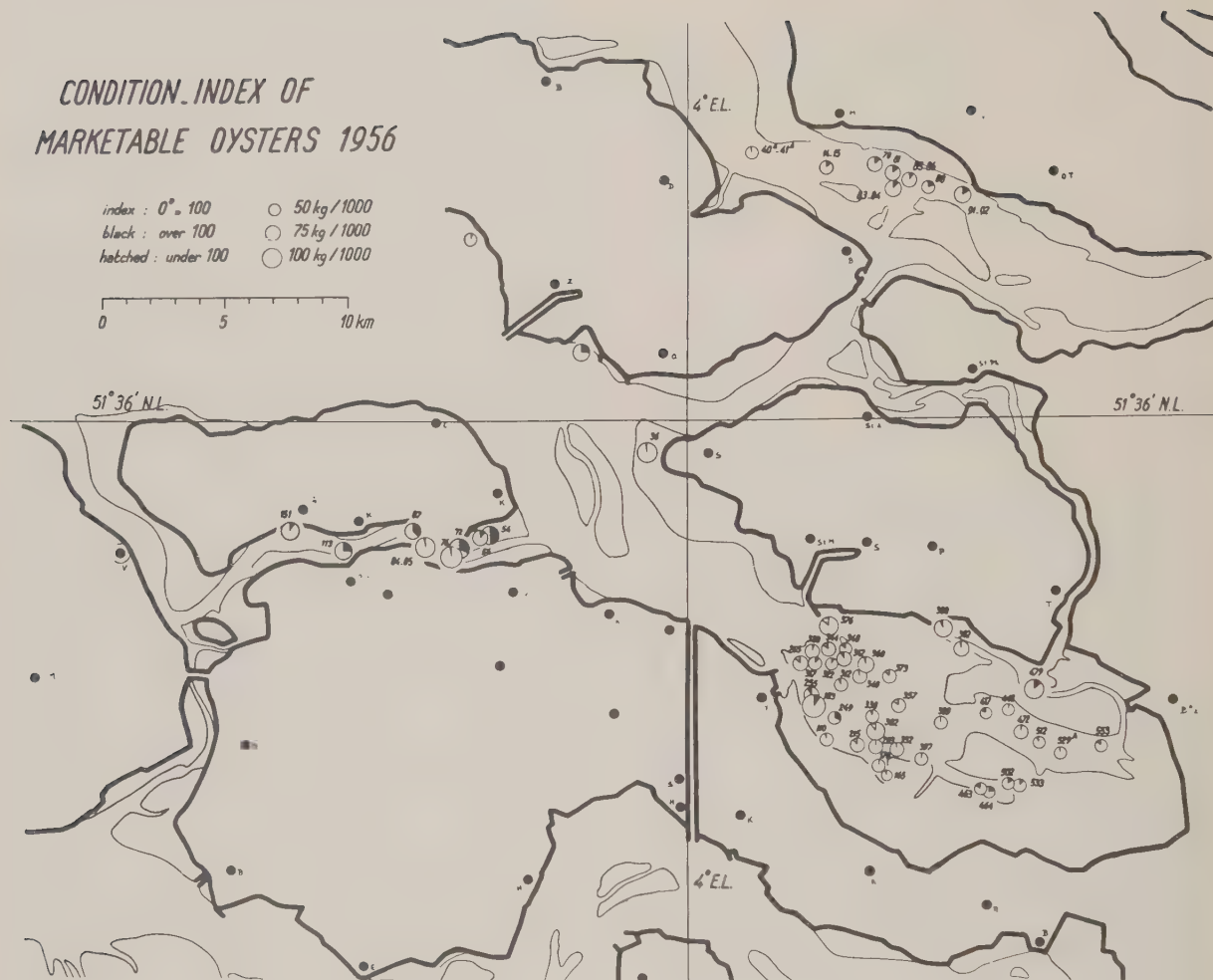


Figure 3.

rising again in April, to remain remarkably constant at some 28‰ in May and June, attaining the "normal" level of 28.5‰ in July and August, but rising to the high level of 30‰ in September, and dropping slightly below 29‰ late in November. 28‰ would have been a normal level for this time of the year. *Hours of sunshine*, so important to the phytoplankton development, were rather numerous in March (106), less than normal in April (110), above average in May (211), far below the average in June (111) and July (137), average in August (151), and few in September (101) and October (75).

*Inorganic phosphate* showed high values early in the year (0.7 to 1.0 µg.-at./l.) dropped sharply to about 0.2 µg.-at./l. in March, declined further to 0.1 µg.-at./l. in April and May, rose gradually to

0.3 µg.-at./l. in June, dropped again to 0.2 in July and August, to rise to 0.3 in September, went up to 0.4 in October, and further to 0.6 and 0.7 later in the year.

*Total phosphorus* figures were, on average, at a higher level than in the year 1955 (1.05 µg.-at./l.) but did not attain the high figures of 1954 (1.5 to 2.0 µg.-at./l.); neither did they remain as constant as in 1954. In the first 3½ months of the year they fluctuated around 1.4 µg.-at./l., to drop to the 1.0 level from late in March till the middle of May, to increase again to 1.5 µg.-at./l. late in May. In June, July, and August the level was remarkably constant but rather low with 1.0 µg.-at./l., rising again to 1.4 in September, declining to 0.8 µg.-at./l. in October, to regain the 1.4 level late in the year. Again about one-third of this appeared to belong to



plankton and detritus, which could be removed by settling for 24 hours, the remainder being either truly dissolved or in a very finely dispersed state.

The quantity of  $KMnO_4$ , necessary to break down the more labile organic matter in 1 litre of water averaged 5 mg. early in the year, and was remarkably constant at  $6\frac{1}{2}$  to 7 mg. per litre from March till August, to drop again to the 5 mg. level in September and to some  $4\frac{1}{2}$  mg. in the remainder of the year. As a rule about  $\frac{1}{5}$  of this could be ascribed to plankton, detritus, and other readily settling matter, slightly more during the spring phytoplankton bloom.

*Phytoplankton* was measured again by extracting chlorophyll, using various filters. Phytoplankton was at a low level early in the year (1.6 mg. chlorophyll/m.<sup>3</sup>), but rose steeply in March, to attain the very same level (60 to 80 mg.) as in the year 1955. Again about  $\frac{1}{3}$  of this could be collected with our finest plankton silk. In April the value dropped from 60 to 20 mg./m.<sup>3</sup>, of which only  $\frac{1}{6}$  could be caught with bolting silk, indicating a predominance of nanoplankton organisms. In May we found from 10 to 20 mg./m.<sup>3</sup>, and only  $\frac{1}{10}$  in organisms big enough to be collected with a plankton net. In June and July the level was rather constant at 15 mg./m.<sup>3</sup> ( $\frac{1}{5}$  of larger size), August showed a slight increment to 20 mg., September a decline to 10 mg. (of which  $\frac{1}{5}$  was large enough to be retained by bolting silk). October gave values of some 10 mg. of which only  $\frac{1}{10}$  appeared to be of larger size. There was no appreciable difference between high slack and low slack water samples. During the main fattening period (August—October) phytoplankton was evidently somewhat poorer than in 1954, and much poorer in 1955 with its excellent growth and fattening. The number of *flagellates* rose to some 3,000/cm.<sup>3</sup> in March and April to attain a peak value of 7,500 in May, fluctuated around some 5,000/cm.<sup>3</sup> in June and July, and around 4,000 in August and September, to drop again to 3,000 and less late in the year.

It may be concluded from these observations that several factors presumably correlated with oyster fattening, showed rather low values in the important months August, September, and October of 1956, whereas the month of May was favourable, which explains the sharp increase in condition in May, leading to profuse swarming of larvae of high viability in the following months, and to the poor recovery and unsatisfactory fattening later in the year. The pattern observed in the main oyster area does not indicate that overcrowding caused the poor fattening. Some data have been collected from the Zandkreek area, where fattening was good in

1956, but these data were not available at the time this contribution was prepared.

P. KORRINGA

## Mussel

### The Quality of Marketable Mussels from the Dutch Waddensea in 1956

(Figures 4–5)

The setting of mussel seed on the natural beds in the Waddensea was very satisfactory in the summer of 1955. This was the more welcome because the 1954 setting was a complete failure and since the supply of mussels of older year-classes was practically exhausted. The mussel farmers stocked their beds well with the 1955 seed. They realized it could hardly be expected that these young mussels would grow so fast that more than just a small minority of them would be of marketable size in the season 1956–1957. As a rule marketable mussels are well over 18 months old. The summer of 1956 being exceptionally cold, with several spells of rough weather, the musselmen feared the worst for the season to come.

We followed the events on 4 Waddensea plots stocked with the same type of 1955 mussels, which had a shell length of slightly over 30 mm. and a volume of some 6 to 7 cc. early in June. Plot *a* (Boereplaat No. 80) was situated in the extreme southern part of the Waddensea, near den Oever on the Isle of Wieringen and in the proximity of the site where surplus fresh water is sluiced from the IJsselmeer to the Waddensea. Plot *b* (Dove Balg No. 253) is situated in the western part of the Waddensea, due east of the Isle of Texel, well

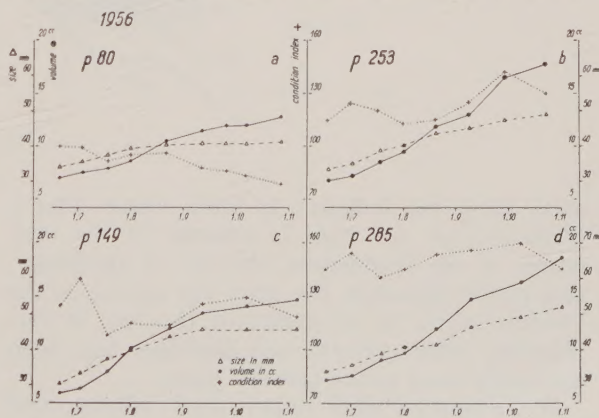


Figure 4.

Figure 4. Condition index and growth in Waddensea mussels from four plots.





Plot *c* showed a fair growth only, and a good quality of the edible parts of the mussels. The condition index followed the same general pattern on plots *b* and *c*, though the July decline was somewhat sharper, and the following increment rather slow. Plot *a* showed a very disappointing growth and a really poor condition. The young mussels were of fair quality early in summer, but the condition decreased steadily and came down to a very low value in autumn. It is clear that the mussels on plot 80 did not live under optimal conditions. Provenance of the mussels being the same, and weather conditions being very similar for all 4 plots, local conditions are to blame for the poor results here. It is highly probable that the huge volumes of fresh water sluiced into the Waddensea in the vicinity of plot 80, are responsible for the poor growth and bad condition of the mussels here. It was not only the wet summer of 1956 which produced an excess of fresh water in the IJsselmeer, but also the reclamation of a new polder in the eastern part of the IJsselmeer, which led the sluicing out of impressive quantities of fresh water.

The excellent growth and fattening, far better than one dares to expect in an average year, was not only observed on our experimental plots, but — much to the relief of the mussel farmers — also on many of the other plots in the western part of the Waddensea. It was not just a small quantity of older mussels and an occasional lot of rapidly

developing 1955 mussels which could be marketed in the season 1956—1957, but in fact one could sell huge quantities of the young mussels, the total sales from the Waddensea amounting to 46,000,000 kg., whereas only some 13,750,000 kg. could be marketed from the plots in the Zealand waters.

Just how good the condition of the young mussels was in the winter season 1956—1957 is shown by charting the condition indices, measured from commercial samples (Figure 5). In many a place, especially in the northern part of the Waddensea, indices of 150 and over have been measured, and we only came across one sample with an index under 100. Feeding conditions must have been very good indeed, and perhaps it was also the rather low summer temperatures which allowed the mussels to grow fast and to become so well-fished. A disadvantage was that the shells were rather thin and brittle, so that great care was required in handling and in marketing. It also appeared that the young thin-shelled mussels required fast transportation and should find their way to the table within a shorter time than older thick-shelled mussels.

For the next season the outlook is bright, if nature co-operates. The 1956 results have strengthened our faith in the fertility of the Waddensea waters, and practically all the beds are well stocked with mussels of the 1955 generation. The supply of 1956 seed is very limited.

P. KORRINGA

